Can Alternaria Leaf Spot Be Managed Organically?

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Alternaria leaf spot (ALS) is a fungal disease which causes small black spots that grow into large lesions with characteristic concentric rings on leafs, stems and heads. The disease affects all vegetable *Brassicas* and is of growing concern to NYS cabbage growers because of decreasing efficacy of chemical fungicides to control the disease. There has also been a surge of consumer interest in organic vegetable production and consequently organic cabbage production in NYS has increased 406% from 2008 to 2011. These two trends highlight the need for new strategies to control ALS that can be used by organic growers and those seeking alternatives to chemical fungicides.

Control practices available to organic growers are essentially limited to cultural methods such as crop rotation, use of clean seeds, control of *Brassicaceous* weeds, and control of insect pests that spread disease. My research at Cornell has focused on testing efficacy of commercially available organic fungicides to control the disease, and the use of mulches to prevent disease in fields with infected crop residues present in the soil.

Efficacy of organic fungicides and soil amendments to control ALS. There are a number of organically registered fungicides listed for control of ALS in NYS but the efficacy of these products has not been well studied. The active ingredients of these organic fungicides are biological control organisms or plant defense activators, which have direct activity against plant pathogens or increase the plants ability to fight off disease. The present studies were undertaken in order to test the efficacy of some of these products, as well as two soil amendments with disease suppressive potential. All of the materials tested are registered for use in certified organic systems, as they are listed by the Organic Materials Review Institute (OMRI).

The experiment was carried out at the New York State Agricultural Experiment Station in Geneva, NY in a field with soil classified as Lima silt loam. A randomized complete blocks design was used, with four replicates of 25-ft x 2.5-ft for each of the ten treatments. Five foot buffers were planted between replicate plots and around the perimeter of the experimental area. Biochar was applied at a rate of two tons per acre and vermicompost was applied at a rate of 1.3 tons per acre. Cabbage seedlings ("Gonzales" Johnny's, Maine) were transplanted on 3 July using a two-row transplanter at 2.5-ft row centers and 18-in plant spacing.

Organic pesticides and a conventional chemical fungicide, Quadris (Syngenta Crop Protection LLC, Greensboro, NC, USA) were applied on 3 August at the recommended rates according to their pesticide labels (Table 1). Most treatments were applied to the foliage using a CO_2 sprayer equipped with three 8003 flat fan nozzles delivering 2 L de-ionized water per treatment (50 gal/A) at 50psi. However, two of the treatments (Mycostop and Rootshield) which are not registered for use on leafy vegetables were applied to the soil as drenches using 8 gal of de-ionized water per treatment (100 row feet). Disease severity of ten cabbage plants per replicate plot was measured by estimating the percent leaf area covered in ALS lesions and this data was used to calculate area under the disease progress curve, a measure of disease development over time.

None of the treatments studied significantly reduced ALS severity compared to the untreated control, except for the chemical fungicide—Quadris—that was used as a positive control (Table 4). However, several of the experimental treatments —Mycostop, Serenade, Sonata, Vermicompost, and Biochar— did show slightly lower disease severity than the untreated control at the first time-point (7 days post inoculation). Though these findings were not significant, they do indicate that effective disease control may be achieved with these materials under slightly different conditions of use (ie, multiple applications). There were no significant differences in total weight or marketable weight of cabbage from any treatment, including the positive control, Quadris.

Table 1. Pesticide labeling information and efficacy data for organic fungicides and soil amendments evaluated for control of ALS in cabbage.

Treatment, Rate	Application Method	Labeled for ALS	Labeled for Cole Crops	AUDPC 7 dpi[x]	Relative AUDPC
Control…………………………..	foliar	--	--	0.54 a	0.24 a
Regalia, 3 qt…………………….	foliar	X	X	0.49 a	0.25 a
Mycostop, 30.5 oz……………..	drench	--	X	0.48 a	0.24 a
Serenade ASO, 6 qt…………….	foliar	X	X	0.58 a	0.22 a
Sonata ASO, 4 qt……………….	foliar	--	X	0.46 ab	0.22 a
Double Nickel 55 WDG, 3 lb……	foliar	X	X	0.45 ab	0.23 a
Rootshield WP, 32 oz………….	drench	--	X	0.31 ab	0.22 a
Quadris, 14 fl oz…………………	foliar	X	X	0.44 ab	0.21 a
Vermicompost , 1.31 t………….	soil	--	--	0.39 ab	0.22 a
Biochar, 2 t……………………..	soil	--	--	0.05 b	0.03 b
				$p = 0.0097$	$p < 0.0001$

[z]Area under the disease progress curve (AUDPC). Values not connected by a letter are significantly different. [y]Foliar treatments were sprayed 02 Aug, drench treatments were applied to soil 02 Aug, and soil amendments were incorporated 02 Jul. [x]Days post inoculation.

Use of mulches to control ALS in an infected field. ALS can be spread by seed, by infected transplants, or nearby weed and crop hosts but infected crop residue buried in soil can be one of the most important sources of inoculum. Mulches can enhance crop growth and productivity in many ways—warming soil, increasing soil moisture, and suppressing weed growth— but they can also prevent soil-borne pathogens from being wind or splash dispersed onto a crop. Therefore, the use of mulches to protect a kale crop from soil-borne inoculum and reduce ALS severity was investigated.

Three different mulches—black plastic, biodegradable black plastic ("BioTelo", Johnny's Seeds, Maine), and straw—were compared to a bare-ground control treatment. The experiment was carried out at the New York State Agricultural Experiment Station in Geneva, NY in a field with soil classified as Lima silt loam. Presence of *A. brassicicola* in the field was confirmed by using specific primers in polymerase chain reactions (PCR) of air samples collected using rotorod spore traps. A randomized complete blocks design was used, with four replicates of 25-ft x 5-ft for each of the four treatments. Trickle line was run just off-center in each row and mulches were laid over the trickle tape by hand. Kale transplants ("Winterbor", Johnny's Seeds, Maine) were grown in the greenhouse at NYSAES and were hand transplanted on 05 Jul at 18" in-row spacing. The rest of the field was cover cropped with Sudex to reduce wind dispersal of soil-borne inoculum into the experimental area.

Disease symptoms were slow to develop due to hot, dry conditions during the 2012 growing season, so disease incidence was rated on 19 October by determining the number of plants showing any symptoms of ALS out of the ten plants in the middle of each replicate plot. Disease incidence varied depending on the type of mulch used, with kale plants under straw mulch having significantly lower disease incidence than plants from the bare ground control plots (Figure 1). There were no significant differences in total or marketable yield between treatments but there were significant differences in plant height. Throughout the experiment, plants under straw mulch grew significantly taller than did plants in any other treatment group (Table 2).

Figure 1. Efficacy of mulches to reduce ALS incidence in kale.

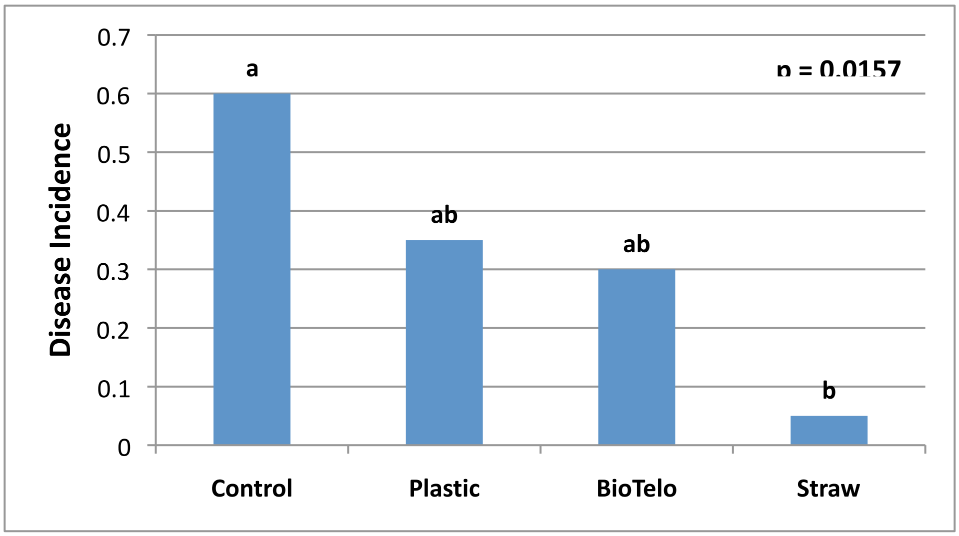

Table 2. Effect of mulches on plant height (cm).

Mulch	24-Jul	1-Aug	13-Aug	26-Aug
Control……	6.3 c	9.9 b	16.0 c	22.6 c
Plastic…….	7.6 b	11.8 b	18.5 b	27.2 b
Biotelo…….	7.7 b	11.2 b	17.8 bc	26.1 b
Straw……..	11.2 a	14.7 a	22.0 a	30.7 a
	$p < 0.0001$	$p = 0.0002$	$p = 0.0002$	$p < 0.0001$

[z]Plant height was measured throughout the course of the experiment as cm from soil surface to base of shoot apical meristem.

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