Effects of Messenger, Zoxium, and other fungicides on growth and diseases of fall spinach

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Interpretative Summary

Regular sprays of Messenger, Zoxium, or Messenger + Zoxium did not significantly affect seedling disease incidence, early growth, or yield of fall spinach. Alternating sprays of Zoxium 80W with Quadris 2.08 F appeared to increase plant biomass five weeks prior to harvest but did not significantly increase yield.

Introduction

Wide-spread advertising in trade publications during the summer of 2001 encouraged the use of Messenger, a new product purported to promote plant health, growth, and yield of numerous crops. The active ingredient in Messenger is the harpin protein, isolated from the bacterium that causes fire blight on fruit trees. The presence of the harpin protein serves as a signal to the host plant that a pathogen is present. This "host recognition" leads to an activation of biochemical defenses throughout the plant that can reduce disease development and new infections, a phenomenon known as systemic acquired resistance (SAR). Based on evidence of the potential SAR-inducing activity of the harpin protein, the product Messenger is actively being marketed for disease management and growth enhancement in a broad spectrum of agricultural production systems. The objectives of this study were (1) to determine the effects of Messenger on growth and diseases of fall spinach, (2) to determine whether the efficacy of Zoxium 80W is affected by Messenger, and (3) to develop data to support an IR-4 registration of Zoxium on spinach.

Materials and Methods

The experiment was conducted during the 2001 growing season at The University of Tennessee's West Tennessee Experiment Station (WTES) on a Calloway-Henry silt loam complex, 0.7% O.M., pH 6.0 (water), with high soil test levels of available P (104 lb/A) and K (283 lb/A). Available Ca, Mg, Zn, Fe, and Mn were >1280, >64, 5, 28, and 65 lbs/A, respectively. A randomized complete block design was used consisting of eight fungicide treatments, each replicated four times. Experimental units were 35-foot-long four-row plots. To maximize the likelihood of natural infection, plots were separated from each other by two unsprayed border rows.

Weeds in the test site in the Horticultural Research Area at the WTES were sprayed with Roundup Ultra (2% solution) on 22 Aug. The field was cut with a field harrow on 14 Sep. Ammonium nitrate (34-0-0) at 84 lb N/A and Ro-neet ½ gal/A were then broadcast over the test area and incorporated with a Triple-K. The test was planted in dry soil 17 Sep

with ‘Hybrid Spinach - Seven R’ at 9 seeds/ft and a 30 in. row spacing using a Monosem pneumatic vacuum planter. Rain on Sep 18-19 (0.96 in.) provided ample moisture for seed germination. Rainfall 23 - 24 Sep added another 0.29 in. water. The weather then turned cooler and moderately dry. A lateral boom was used twice (27 Sep and 2 Oct) to promote seedling emergence.

Eight spray treatments were evaluated: (1) Zoxium 80W @ 0.20 lb a.i./A + Latron CS-7 at 0.125%, (2) Zoxium 80W @ 0.25 lb a.i./A + Latron CS-7 at 0.125%, (3) Zoxium 80W @ 0.30 lb a.i./A + Latron CS-7 at 0.125%, (4) Aliette 80WDG @ 3.2 lb a.i./A, (5) Zoxium 80W @ 0.30 lb a.i./A [1st, 2nd, 4th, and 6th sprays] alternated with Quadris 2.08 F @ 0.30 lb a.i./A [3rd and 5th sprays] + Latron CS-7 at 0.125%, (6) Latron CS-7 at 0.125%, (7) Messenger @ ca. 4.5 oz/acre + de-chlorination agent @ 0.2 oz for <200 gal water + Latron CS-7 at 0.125%, and (8) Messenger @ ca. 4.5 oz/acre + de-chlorination agent @ 0.2 oz for <200 gal water + Zoxium 80W @ 0.20 lb a.i./A + Latron CS-7at 0.125%. All sprays were applied in ca. 17.6 gal water/A at an operating pressure of ca. 20 psi using a John Deere 900 tractor equipped with a horizontal boom with TXVS12 hollow cone nozzles set 18 in. apart. Fungicide sprays were applied 4, 17, and 29 Oct and 7, 14, and 26 Nov.

Disease incidence, plant growth, and phytotoxicity data were collected on the center 25 feet of the two center rows in each plot. Healthy stand and damped-off seedling counts were recorded 5 Oct and 16-17 Oct. Dying seedlings were collected for pathogen identification. Differences in seedling vigor were recorded 5 Oct by measuring to the nearest cm the length of the blade of the first true leaf on ten representative plants per row. Differences in plant growth were documented 22 Oct by measuring to the nearest cm the width of plants at five locations per row. Plots were examined every two weeks for foliar diseases and any evidence of treatment phytotoxicity. The effects of treatments on spinach yield were determined by hand-harvesting all the plants in one data row of each plot (25 row-ft), replications 1- 3 on 4 Dec and replication 4 on 5 Dec.

To encourage disease development, plants at five sites in the border rows between replications 1 and 2 plus five sites in the border rows between replications 3 and 5 were inoculated with spores of *Albugo occidentalis*, the causal agent of white rust of spinach, in the early evening of 30 Oct. Data rows in replication 1 (north side of test area) were dusted with spores of *A. occidentalis* on 30 Oct and in replication 4 (south side of test area) on 31 Oct.

Results and Discussion

Despite ample rainfall during the test period, the inoculation of border rows with *A. occidentalis*, and the dusting of the data rows in two replications with spores of this fungus, no white rust developed in data rows nor did any other foliar diseases. No treatment phytotoxicity was observed. High moisture conditions did lead to damping-off losses, particularly in portions of plots that were poorly drained. Healthy stands 5 Oct

were significantly lower with Aliette 80 WDG than with any other treatment except the lowest rate of Zoxium (Table 1). Damping-off pathogens were tentatively identified as a *Phytophthora* sp. and *Fusarium* sp. The stand differences were no longer apparent when the 2nd counts were recorded 16-17 Oct.

Significant treatment effects on plant growth were rare. Treatments had no significant effects on the length of the first true leaf or on plant width (Table 1). Plot yields were also unaffected by treatment, even when corrected for differences in plant stand due to damping-off losses (Table 2). Use of Messenger, alone or in combination with Zoxium 80W, had no apparent effect on healthy stand, plant growth, or yield.

There were some significant differences in an estimate of relative plant biomass on 22 Oct. This variable was calculated using the plant widths of 22 Oct and the healthy stands of 16-17 Oct. Estimated relative plant biomass with alternating sprays of Zoxium 80W and Quadris 2.08 F, both at 0.30 lb a.i./A, was significantly greater than with any other treatment except the Aliette 80WDG (Table 2). The apparent contradiction between low stands with Aliette 80 WDG (Table 1) and a high biomass estimate (Table 2) is largely resolved by realizing that stand counts were based on both data rows, while the biomass estimates are significantly different only when the one harvested row is used in the calculation. When both rows are used to calculate relative biomass differences on 22 Oct, the significant difference disappears (Table 2).

In this fall 2001 field test on spinach, regular sprays of Messenger or Messenger + a fungicide did not significantly increase plant growth or spinach yield nor did they significantly affect the incidence of seedling diseases. Additional testing is needed to better understand the circumstances needed for the SAR induction and growth enhancement purported to occur with Messenger.

Table 1. Effects of Zoxium, other foliar fungicides, and Messenger (harpin protein) on spinach stand and growth, Jackson, TN, Fall 2001 [1]

Treatment [2]	Healthy stand (%) [3]		Mean leaf length (cm) [4]	Mean plant width (cm) [5]
	5 Oct	16-17 Oct	5 Oct	22 Oct
1) Zoxium 80W @ 0.20 lb a.i./A + Latron CS-7 at 0.125%	56 ab	38	2.3	12
2) Zoxium 80W @ 0.25 lb a.i./A + Latron CS-7 at 0.125%				

	58 a	40	2.1	11
(3) Zoxium 80W @ 0.30 lb a.i./A + Latron CS-7 at 0.125%	59 a	40	2.3	12
(4) Aliette 80WDG @ 3.2 lb a.i./A	51 b	36	2.3	13
(5) Zoxium 80W @ 0.30 lb a.i./A [or Quadris 2.08 F @ 0.30 lb a.i./A] + Latron CS-7 at 0.125%	60 a	46	2.5	15
(6) Latron CS-7 at 0.125%	56 a	34	2.3	12
(7) Messenger @ ca. 4.5 oz/acre + de-chlorination agent @ 0.2 oz for <200 gal water + Latron CS-7 at 0.125%	56 a	38	2.2	12
(8) Messenger @ ca. 4.5 oz/acre + de-chlorination agent @ 0.2 oz for <200 gal water + Zoxium 80W @ 0.20 lb a.i./A + Latron CS-7 at 0.125%	60 a	41	2.3	11
ANOVA F Value	3.36	1.03	0.60	1.40
Prob. > F	0.01	0.44	0.75	0.26

[1] The test was planted 17 Sep with 'Hybrid Spinach - Seven R', 9 seed/ft, 30 in. row spacing.

[2] Treatments were applied six times: 4, 17, and 29 Oct and 7, 14, and 26 Nov.

[3] Values are the means of four replications, two 25-foot-long rows/rep. Means followed by the same letter are not significantly different by Fisher's (protected) LSD (P=0.05).

[4] Values are the mean length of the first true leaf of 10 representative plants/tow.

[5] Values are the mean plant width of 5 representative plants/tow.

Table 2. Effects of Zoxium, other foliar fungicides, and Messenger (harpin protein) on relative plant biomass and yield, Jackson, TN, Fall 2001 [1]

Treatment [2]	Relative plant biomass 22 Oct [3]		Mean plot yield (lb) [4]	Mean plant yield (g)
	Harvest row	Both rows		
1) Zoxium 80W @ 0.20 lb a.i./A + Latron CS-7 at 0.125%	4691 b	4585	17.96	102
2) Zoxium 80W @ 0.25 lb a.i./A + Latron CS-7 at 0.125%	4401 b	3941	16.55	84
3) Zoxium 80W @ 0.30 lb a.i./A + Latron CS-7 at 0.125%	6152 b	4791	16.96	83
4) Aliette 80WDG @ 3.2 lb a.i./A	6629 ab	4832	18.36	94
5) Zoxium 80W @ 0.30 lb a.i./A [or Quadris 2.08 F @ 0.30 lb a.i./A] + Latron CS-7 at 0.125%	9672 a	7994	20.77	89
6) Latron CS-7 at 0.125%	4403 b	4257	14.16	96
7) Messenger @ ca. 4.5 oz/acre + de-chlorination agent @ 0.2 oz for <200 gal water + Latron CS-7 at 0.125%	4491 b	4153	15.80	82
8) Messenger @ ca. 4.5 oz/acre + de-chlorination agent @ 0.2 oz for <200 gal				

water + Zoxium 80W @ 0.20 lb a.i./A + Latron CS-7 at 0.125%	4667 b	4185	16.17	77
ANOVA F Value	3.04	1.85	0.99	0.81
Prob. > F	0.02	0.13	0.46	0.59

[1] The test was planted 17 Sep. Values are the means of four replications of 'Hybrid Spinach - Seven R' (ca. 225 planted seeds/row).

[2] Treatments were applied six times: 4, 17, and 29 Oct and 7, 14, and 26 Nov.

[3] Relative differences in plant biomass were calculated by multiplying the number of healthy plants/row on 16-17 Oct X plant width on 22 Oct X estimated plant height on 22 Oct (estimated height = 1/3 plant width). Means followed by the same letter are not significantly different by Fisher's (protected) LSD (P=0.05).

[4] Weight spinach harvested 4-5 Dec from one 25-foot-long row.

[5] Weight spinach harvested 4-5 Dec divided by the number of healthy/row 16-17 Oct.

This research represents one season's data and does not constitute recommendations. After sufficient data is collected over the appropriate number of seasons, final recommendations will be made through research and extension publications.