EFFECT OF APPLICATION TIMING OF MESSENGER™ ON THE PHYSIOLOGY AND YIELD OF FIELD-GROWN COTTON

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RESEARCH PROBLEM

Recently, concern for the protection of the environment has escalated. This has inspired agricultural researchers to develop non-toxic crop protectants, often borrowing from nature itself. One such product is Messenger™ (Eden Bioscience, Seattle, WA), which contains the protein, harpin, isolated from bacterial plant pathogens. The protein is responsible for inducing a plant's natural defense mechanism. Preliminary studies have shown that Messenger may improve yields in a variety of crops including cotton (Wright et al., 2000)

BACKGROUND INFORMATION

The active ingredient in Messenger is harpin, an extracellular protein isolated from bacterial plant pathogens. Harpin activates a plant's natural defense mechanisms by inducing systemic acquired resistance. Foliar applications of Messenger can potentially improve cotton yields by providing resistance to a broad range of diseases and pests. Messenger has shown success in a variety of crops, including tomato (*Lypersicon esculentum* L.) and wheat (*Triticum aestivum* L.) in regard to pest management and yield enhancement.

RESEARCH DESCRIPTION

This study was conducted at the University of Arkansas Agricultural Research and Extension Center in Fayetteville in 2001 to determine the effects of Messenger on the yield and physiology of field-grown cotton. Cotton (*Gossypium hirsutum* L.) cultivar, Sure-Grow 215 BR, was planted into a Captina silt loam on 25 May 2001, in a

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randomized complete block design with five replications. Pest control and fertilizer management were according to Arkansas Cooperative Extension Service cotton production recommendations. Plots consisted of 4 rows, 36 feet in length, spaced 40 inches apart. The product was mixed with deionized water and applied at a volume of 10 gallons/acre with a CO_2 backpack sprayer. No adjuvant was used. All treatments were applied at a rate of 2.25 oz./acre. Treatments consisted of 1) untreated control; 2) Messenger applied at 2nd true leaf (2L); 3) Messenger applied at pinhead square (PHS); 4) Messenger applied at first flower (FF); 5) Messenger applied at 2nd TL, PHS, and FF; 6) Messenger applied at PHS and FF.

At one and three weeks after FF, leaf material was collected in the morning for nutrient analysis. On the same day within one hour of solar noon, gas exchange rates were evaluated in select treatments with a LI-COR 6200 (LICOR Environmental Services, Lincoln, NE). Plant mapping was performed using the COTMAP system (Bourland and Watson, 1990). Yield was determined by hand-harvesting 1m of row from each of the two middle rows in all five replications. Seedcotton was weighed for yield and aliquots from each plot were sent to STARLABS (Knoxville, TN) for gin turnout and fiber quality assessment.

RESULTS

Leaf Nutrient Concentrations

Mild potassium deficiencies were observed at FF (Table 1). While foliar applications were made to correct the deficiencies, potassium concentrations were even more deficient at FF + 3 weeks (Table 2). These deficiencies did not appear to be influenced by treatment or replication. It is suggested that in 2002 we investigate the effect of potassium deficiency on Messenger response in the potassium-water stress study at Clarkedale. Zinc levels and phosphorus were lowest in untreated control plants at both sampling times. At FF+3 weeks, several nutrients were lower in untreated control plants, including nitrogen, sodium, copper, and manganese.

Gas Exchange

Significant differences were observed in gas exchange data at FF +3 weeks, but not at FF +1 week (Table 3). At FF + 3 weeks, all Messenger-treated plants had significantly higher photosynthetic rates compared to untreated control plants. Although significant differences existed in transpiration rate at FF+3 weeks, these differences were not between Messenger-treated and untreated plants. No differences were observed in intercellular CO_2 rates. At FF+3 weeks, plants receiving Messenger application at FF had significantly higher stomatal conductance compared to untreated control plants.

Yield

While no significant differences were present in yield components (Table 4), untreated control plants had the lowest adjusted seedcotton yield. Messenger-treated plants generally had higher boll number and decreased boll weights compared to untreated plants. No differences were found in gin turnout percentages.

PRACTICAL APPLICATION

Even though yields were not significantly increased by foliar application of Messenger, numerical trends suggest that Messenger could potentially enhance cotton production. No major pest problems were encountered during the season, thus limiting the evaluation of the protective benefits attributed to the harpin protein.

LITERATURE CITED

Bourland, F.M., and C.E. Watson, Jr. 1990. COTMAP, a technique for evaluating structure and yield of cotton plants. Crop Sci. 30:224-226.

Wright, D.L., P.J. Wiatrak, S. Grzes, and J. Pudelko. 2000. Messenger: A systemic acquired resistance influence on cotton. pp. 617-619. *In:* P. Dugger and D.A. Richter (eds.). Proc. Beltwide Cotton Conference. National Cotton Council, Memphis, Tennessee.

Table 1. Leaf nutrient concentration at one week after FF.

Treatment	N	P	K	Ca	Mg	Na	Cu	Zn	Fe	Mn
	(%)						(ppm)			
Untreated control	5.03	0.40	1.30	3.95	0.50	0.06	8	71	127	30
2TL	4.81	0.41	1.34	3.92	0.54	0.08	7	83	125	27
PHS	5.15	0.46	1.28	4.10	0.57	0.08	5	78	110	29
FF	5.02	0.41	1.15	3.89	0.50	0.08	5	77	120	30
2nd TL, PHS, & FF	5.21	0.41	1.36	3.95	0.53	0.07	5	75	121	29
PHS & FF	5.05	0.41	1.33	4.05	0.56	0.07	7	77	136	29

Table 2. Leaf nutrient concentration at three weeks after FF.

Treatment	N	P	K	Ca	Mg	Na	Cu	Zn	Fe	Mn
	(%)						(ppm)			
Untreated control	3.62	0.39	1.16	3.79	0.44	0.07	9	69	86	18
2nd TL	4.01	0.47	1.24	3.68	0.45	0.08	10	86	81	22
PHS	4.15	0.46	1.29	3.96	0.43	0.08	12	98	98	19
FF	4.04	0.44	1.09	3.79	0.47	0.09	10	74	116	18
2nd TL, PHS, & FF	4.10	0.43	1.00	3.95	0.47	0.09	10	72	84	22
PHS & FF	4.10	0.41	1.14	3.77	0.42	0.09	13	71	90	18

Table 3. Physiological data from select treatments at one and three weeks after FF and the last Messenger application.

Treatment	Net photosynthesis[z]		Transpiration		Intercellular CO_2		Stomatal conductance	
	FF+1 wk	FF+3 wks	FF+1 wk	FF+3 wks	FF+1 wk	FF+3 wks	FF+1 wk	FF+3 wks
	------- ($mol/m^2/sec$) ------		------- ($mol/m^2/sec$) -------		----------- (ppm) -----------		-------- (cm_2/sec) ---------	
Untreated control	29.7	29.8 b	0.0260	0.0196 ab	306.5	320.2	6.9	3.4 b
FF	33.7	34.1 a	0.0258	0.0188 b	318.9	327.1	6.6	4.0 a
2L, PHS, FF	31.7	33.4 a	0.0260	0.0204 a	313.0	308.5	6.6	3.6 ab
PHS, FF	29.7	33.4 a	0.0259	0.0189 b	311.4	322.4	6.9	3.4 b
LSD (P=0.05)	NS[y] (5.3)	3.5	NS (0.001)	0.0013	NS (29.4)	NS (23.5)	NS (1.4)	0.5

[z] Values in a column with the same letters are not significantly different at the P=0.05 level.
[y] NS = not significant

Table 4. Yield and yield components at time of harvest.

Treatment	Seedcotton	Adjusted seedcotton[z]	Boll weight	Total bolls[y]	Lint
	(lb/acre)	(lb/acre)	(g/boll)	(#/acre)	(%)
Untreated control	1658	1896	5.3	165444	38.0
2L	1654	1937	4.6	191622	39.2
PHS	1674	1930	4.6	190575	37.6
FF	1771	2129	4.7	206282	37.4
2L, PHS, & FF	1711	1990	4.8	190575	38.8
PHS & FF	1686	1958	4.8	186387	38.0
LSD (P=0.05)	NS[x] (341)	NS (434)	NS (0.78)	NS (41885)	NS (2.03)

[z] Extrapolated value if all mature green bolls were open
[y] Represents open bolls *plus* mature-sized green and hardlocked bolls
[x] NS = not significant