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Aphanomyces-Resistant Alfalfa: A Solution to a Common Problem in Spring Seedings

Paul Vincelli, Jimmy Henning, Tim Hendrick, Jerry Brown, L. J. Osborne, Beth Prewitt, Val Shields, Don Sorrell, Kim Strohmeier, Ray Tackett and Joe Wyles¹

INTRODUCTION

For several decades, farmers have experienced a common stand-establishment disease syndrome when spring-seeded alfalfa was followed by extended periods of wet weather. Seedlings affected by this syndrome exhibit severe stunting as well as yellowing and reddening of seed leaves (cotyledons), but they do not wilt or collapse, as they might from a damping-off disease. Commonly, the problem affects most or all of the field.

Based on research that began in the 1980's, we suspected that a fungus called *Aphanomyces euteiches* (hereafter simply called *Aphanomyces*) was responsible. This root-rot fungus can be found in the majority of alfalfa fields we have sampled in central and western Kentucky. However, for many years we lacked conclusive proof that *Aphanomyces* was, in fact, the cause of this common problem in spring-seeded alfalfa. We also did not have rigorous proof that the syndrome could be avoided by sowing *Aphanomyces*-resistant alfalfa varieties, which started becoming commercially available in the early 1990's. In this report, we provide a brief summary of research to support our new recommendation: that *spring-seeded alfalfa should be sown only with varieties having an R or HR rating to Aphanomyces root rot (ARR)*.

METHODS

Two trials were conducted that included alfalfa varieties representing a wide range of levels of susceptibility and resistance to *Aphanomyces*. Both trials were sown into a prepared seed bed using a disc drill. Varieties were sown at 20 lb seed/A and plots were arranged in a randomized complete block design with four replicates.

Eden Shale Farm near Owenton. The site had been in KY31 tall fescue and had not been sown to alfalfa in several decades.

The Heitt silt loam soil at the study site was naturally infested with both *Aphanomyces* and *Phytophthora medicaginis*,

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another root-rot fungus known to attack alfalfa. Plots measuring 4 X 19 ft were seeded on April 18, 1996. Whole-plot assessments of overall seedling health were made visually by three observers six weeks after seeding. Symptomatic seedlings were also collected, and fungi were isolated in the laboratory. Whole-plot assessments of alfalfa ground cover were made visually on several dates. Plots were harvested with a sickle-bar mower on July 11 1996, August 22-24 1996, and May 21 1997. The samples collected from each plot during the latter two harvests were heavily infested with weeds. These were hand-separated into alfalfa and all other plant matter, and sub-samples were dried at 90-100°F and weighed to allow calculation of the amount of alfalfa dry matter in each plot.

UKREC Farm in Princeton. The Crider silt loam soil at the study site was naturally infested with *Aphanomyces*. Plots measuring 5 X 15 ft were seeded on April 10 1997. Whole-plot assessments of plant color and vigor were made visually two months after seeding. Symptomatic seedlings were collected one week later for laboratory testing. Plots were harvested with a sickle-bar forage plot harvester on dates reported herein.

RESULTS

Eden Shale Test. A severe outbreak of the syndrome suspected to be ARR developed during the four-week period following seeding. A total of 13.5 inches of precipitation was uniformly distributed during that period. Plants in the most severely affected plots were typically less than one inch tall six weeks after seeding, and remained at that height for most of the summer. *Aphanomyces* was detected readily in rotted roots of symptomatic plants; no other pathogens were detected.

Varieties differed greatly in the level of seedling health, and increased seedling health was generally associated with increasing resistance to ARR (Table 1). Yields from the first harvest (July 11 1996) are not included in Table 1, because the level of weed infestation may have differed among varieties exhibiting different levels of seedling health, which could confound detection of effects due to ARR resistance. Following the first cutting, the vigor of alfalfa, as measured by percent groundcover twelve days after cutting, differed greatly among varieties (Table 1). Increased health was again generally associated with increasing levels of ARR resistance. Alfalfa yield on August 22-24 1996 was generally greatest in alfalfa varieties with an 'R' or 'HR' rating to ARR.

One year after seeding, large differences in stand vigor and yield were observed among varieties, with increasing agronomic performance generally correlated to increasing ARR resistance (Table 2). The most notable exception to this trend was the performance of 'Saranac AR'. The resistance level of 'Saranac AR' to ARR has not been characterized, although it is reasonable to assume that it has either an S or LR rating, as is typical for

varieties not deliberately screened for ARR resistance. Nevertheless, 'Saranac AR' was only moderately affected by the disease in 1996, and was the top yielding variety in 1997. Such performance was exceptional among varieties known or suspected to be susceptible, and it suggests that this variety possesses some tolerance or ability to recover from severe outbreaks of ARR under certain conditions.

The results with the variety 'Gem' are significant. This variety is highly resistant to *Phytophthora* root rot and is susceptible to ARR, and it suffered severe damage from the outbreak of ARR observed. These results reinforce the conclusion that *Aphanomyces* was the principal root-rotting fungus responsible for the crop damage observed.

UKREC Test. A moderate outbreak of ARR developed during the four-week period following seeding. A total of 4.6 inches of precipitation was uniformly distributed during that period. Plants in the most severely affected plots typically were 3-6 inches tall two months after seeding, as compared to 18-20 inches in the healthiest plots. *Aphanomyces* was detected readily in rotted roots of symptomatic plants; no other pathogens were detected.

Although varieties exhibited a great range in seedling health on June 10 1997, varietal yields did not differ significantly in 1997 (Table 3). Over a two-year period 'Saranac AR' and 'Arc'--varieties without any reported resistance to ARR--provided significantly less yield than the top-yielding variety (Table 3). 'Saranac AR' did not show evidence in this trial of more rapid recovery than other susceptible varieties, as it did in the Eden Shale trial. This suggests that the tolerance observed in 'Saranac AR' in the Eden Shale trial is only observed under certain environmental conditions.

DISCUSSION

These results provided conclusive evidence that an alfalfa seedling syndrome commonly observed in central and western Kentucky is due to *Aphanomyces*.

The Eden Shale trial was conducted on a Heitt silt loam, a soil with a slow percolation rate in the 'B' horizon. The combination of heavy rainfall after planting and poor internal drainage led to severe disease pressure in that trial, typical of what commonly has been observed in many commercial fields. Under these conditions, increasing seedling health and crop performance were generally associated with increasing levels of ARR resistance, and the detrimental effects of the disease on stand health and agronomic performance were evident in susceptible varieties even into the year following seeding. This is the first report of such dramatic long-term effects from ARR.

The UKREC trial was conducted on a Crider silt loam, a soil series which commonly has excellent internal drainage to a depth of 60+ inches. The excellent internal drainage of the soil and

near-normal rainfall during the period following seeding resulted in moderate disease pressure in that trial. In that case, alfalfa varieties with an MR rating or higher provided acceptable agronomic performance.

NEW RECOMMENDATION

Based on our previous research and the results summarized here, UK now recommends ARR-resistant varieties when sowing alfalfa in the spring. Because of their more consistent performance under high disease pressure, we recommend using varieties with an R or HR rating for ARR resistance, especially on soil series with low percolation rates in the subsoil.

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Table 1. Response of Alfalfa Varieties to Aphanomyces Root Rot, Eden Shale Farm, in 1996 (seeded April 18, 1996).

Variety	Aphanomyces resistance ratings ¹	Seeding health score (30 May 96) ^{2,3}	Percent groundcover (23 Jul 96) ^{3,4}	Tons dry matter/A (22-24 Aug 96) ³
DK 133	R	3.7 a	54 abc	0.11 abcde
Legacy	R	3.6 a	59 ab	0.14 ab
Affinity + Z	R	3.2 ab	52 abc	0.12 abcd
DK127	HR	3.2 ab	55 abc	0.08 cdefg
TMF - Generation .	R	3.2 ab	56 ab	0.11 abcde
Depend + EV	R	3.1 ab	64 a	0.15 a
WL 324	HR	3.1 ab	54 abc	0.12 abc
645	MR	2.7 ab	50 abc	0.11 abcde
Choice	R	2.7 ab	46 abc	0.11 abcde
Rushmore	HR	2.7 ab	41 bc	0.10 bcdef
Supercuts	R	2.6 abc	47 abc	0.11 abcde
Saranac - AR	-	2.2 bcd	37 cd	0.10 bcdef
Apollo	-	1.5 cde	20 de	0.08 cdefgh
WL 252HQ	LR	1.2 de	20 de	0.06 efgh
631	MR	1.2 de	20 de	0.07 defgh
Fortress	-	1.2 de	22 de	0.05 fgh
Gem	S	1.0 e	21 de	0.05 fgh
Buffalo - B	-	0.9 e	8 e	0.03 gh
Arc	-	0.7 e	9 e	0.03 h
Buffalo - A	-	0.6 e	6 e	0.04 gh

¹Resistance ratings as S = Susceptible (0-5% resistant plants), LR = Low resistance (6-14% resistant), MR = Moderate resistance (15-30% resistant), R = Resistance (31-50% resistant), HR = High resistance (>50%), "-" represents no reported resistance.

²Scored as 0 to 5, where 0 = plants extremely stunted throughout plots and 5 = very good seedling health.

³Means followed by the same letter are not significantly different, Waller-Duncan k-ratio test (k = 100, P = 0.05).

⁴Assessed 12 days after the first cutting.

Table 2. Response of Alfalfa Varieties Aphanomyces Root Rot, Eden Shale Farm, in 1997 (seeded April 18, 1996).

Variety	Aphanomyces resistance ratings ^{1,2}	Percent alfalfa ground cover (17 April 97) ²	Tons dry matter/A (21 May 97) ²
Saranac - AR	-	61 a	1.38 a
Depend + EV	R	65 a	1.27 ab
DK127	HR	53 abc	1.21 abc
Choice	R	47 bcd	1.18 abc
WL 252HQ.....	HR	46 cd	1.14 abcd
Affinity + Z	R	45 cde	1.11 abcde
Supercuts	R	60 ab	1.11 abcde
Rushmore	HR	47 bcd	1.08 abcde
WL 324	HR	46 cd	1.08 abcde
645	MR	53 abc	1.08 abcde
TMF - Generation	R	44 cdef	1.04 abcdef
631	MR	38 defg	1.02 abcdef
Legacy	R	39 def	0.94 bcdef
Gem	S	31 fgh	0.86 cdefg
DK 133	R	33 efgh	0.77 defgh
Fortress	-	36 defg	0.76 efgh
Apollo	-	25 ghi	0.69 fgh
Arc	-	20 hi	0.49 gh
Buffalo - A	-	16 i	0.47 h
Buffalo - B	-	12 i	0.43 h

¹Resistance ratings as S = Susceptible (0-5% resistant plants), LR = Low resistance (6-14% resistant), MR = Moderate resistance (15-30% resistant), R = Resistance (31-50% resistant), HR = High resistance (>50%), "-" represents no reported resistance.

²Means followed by the same letter are not significantly different, Waller-Duncan k-ratio test (k = 100, P = 0.05).

Table 3. Response of Alfalfa Varieties to Aphanomyces Root Rot in 1997-98,

UKREC Farm (seeded April 10, 1997).

Variety	Aphanomyces resistance rating ¹	Color ² June 10	Vigor ³ June 10	Tons dry matter/A ⁴		
				1997	1998	Total
Choice	R	4.00 *	4.38 *	1.91 *	5.07 *	6.97 *
Feast	R	4.00 *	3.88 *	1.82 *	4.63 *	6.44 *
Rushmore	HR	3.88 *	3.50 *	1.81 *	4.79 *	6.61 *
ABT 405	R	3.75 *	3.38 *	1.73 *	5.01 *	6.74 *
WL326GZ	HR	3.50 *	3.75 *	1.67 *	4.69 *	6.36 *
631	MR	3.13 *	3.50 *	1.65 *	4.69 *	6.34 *
WL332SR	HR	3.63 *	3.63 *	1.64 *	4.64 *	6.28 *
Wintergreen	R	3.50 *	3.25 *	1.62 *	4.88 *	6.50 *
ABT205	R	3.63 *	3.38 *	1.50 *	4.64 *	6.14 *
Amerigraze 401+Z..	R	4.13 *	3.75 *	1.50 *	4.82 *	6.31 *
Fortress	-	3.00 *	3.00 *	1.48 *	4.70 *	6.18 *
Gem	S	2.75 *	2.75 *	1.37 *	4.84 *	6.21 *
Arc	-	2.38	2.50	1.19	4.56 *	5.75
Saranac - AR	-	1.88	1.88	1.22	4.37	5.60

¹Resistance ratings as S = Susceptible (0-5% resistant plants), LR = Low resistance (6-14% resistant), MR = Moderate resistance (15-30% resistant), R = Resistance (31-50% resistant, HR = High resistance (>50%), "-" represents no reported resistance.

²0 to 5 scale, with 5 = dark green and 0 = yellow.

³0 to 5 scale, with 5 = very vigorous and 0 = very stunted.

⁴Means with an asterisk not significantly different from the highest numerical value in the column, LSD test, P = 0.05.