Chemical Control of Anthracnose: Updates from the NE-1025 Project

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Challenges in Anthracnose Control with Fungicides

- stress-induced disease
- limited curative control options
- timing of initial infections unknown
- fungicide resistance develops quickly
- single chemistries rarely provide acceptable control

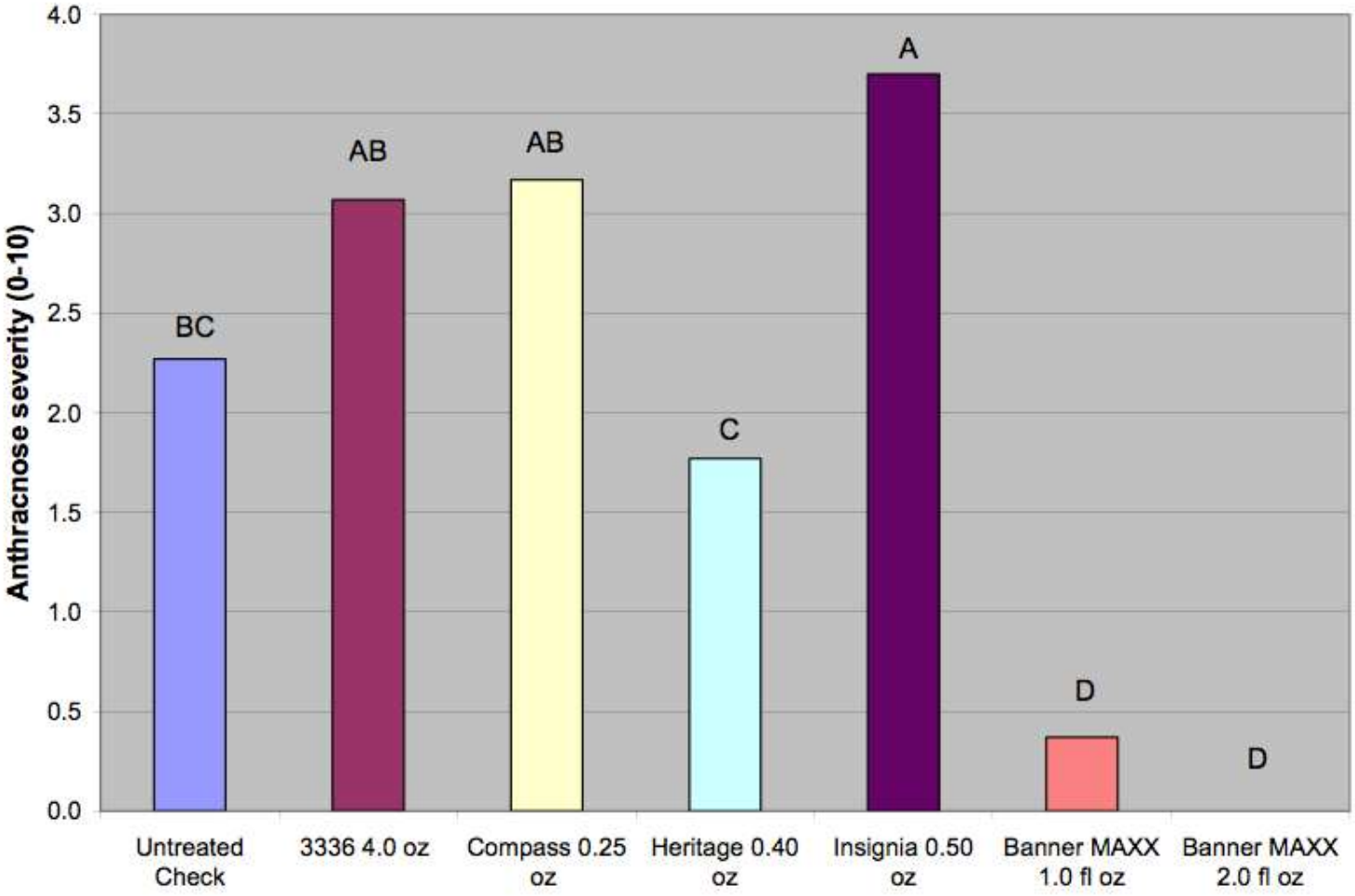
Current Options for Anthracnose Control

Chemical Class	Common Names
benzimidazole	thiophanate-methyl
DMI	metconazole, myclobutanil, propiconazole, triticonazole, triadimefon
hydrocarbon	mineral oil
nitrile	chlorothalonil
phenylpyrolle	fludioxonil
phosphonates	fosetyl-Al, phosphite salts
polyoxin	polyoxin D
QoI	azoxystrobin, fluoxastrobin, pyraclostrobin, trifloxystrobin
SDHI	penthiopyrad

Efficacy Rankings for Anthracnose Control

Common Name	Chemical Class	Trade Name(s)	Tredway	Vincelli
azoxystrobin	QoI	Heritage	++++	3
fluoxastrobin	QoI	Disarm	++++	3
pyraclostrobin	QoI	Insignia	++++	3
tebuconazole	DMI	Torque	++++	3
chlorothalonil	nitrile	Daconil, Chlorostar, Chlorothalonil, Echo, Legend	+++	3
metconazole	DMI	Tourney	+++	3
triticonazole	DMI	Trinity, Triton	+++	3
polyoxin D	polyoxins	Endorse, Affirm	+++	3
fludioxonil	phenylpyrolle	Medallion	+++	2+
myclobutanil	DMI	Eagle, Myclobutanil	+++	2
propiconazole	DMI	Banner, Kestrel, Propinconazole, Savvi, Spectator	+++	2
thiophanate-methyl	benzimidazole	3336, Systec, T-Bird, T-Storm, TM	+++	2
triadimefon	DMI	Bayleton	++	1+
trifloxystrobin	QoI	Compass	++	3+
mineral oil	hydrocarbon	Civitas	+	2+

The Reality - Fungicide Resistance



Field Performance of QoI & Benzimidazole Fungicides 2003
Penn State Data – W. Uddin
7 applications at 14-day intervals

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Colletotrichum cereale develops resistance to fungicides quickly

Benzimidazoles

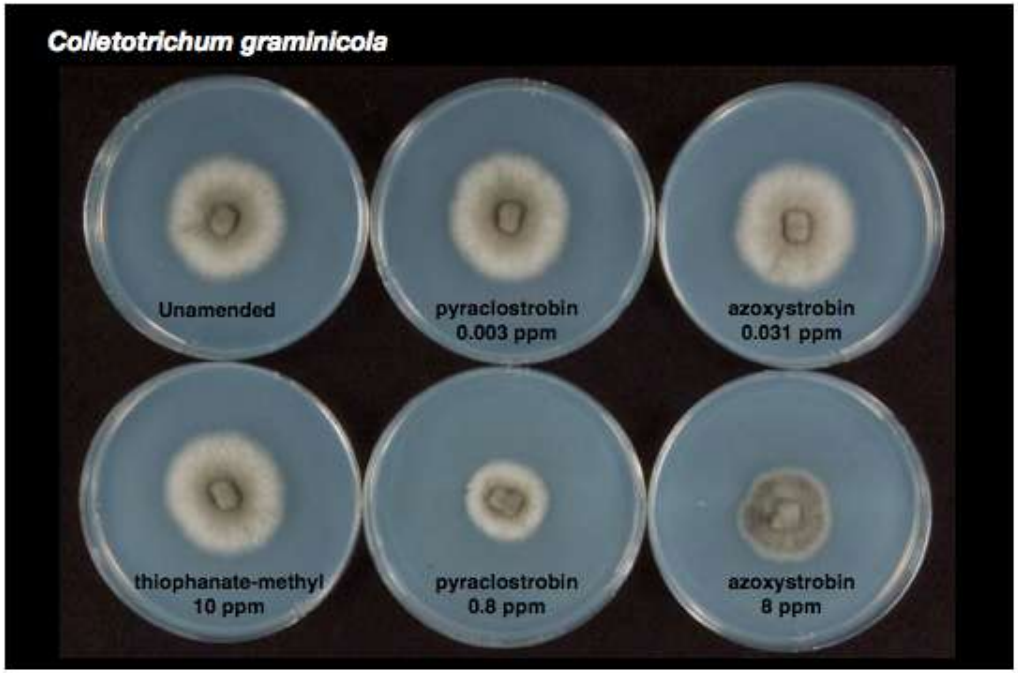
- single mutation in b-tubulin gene

QoIs

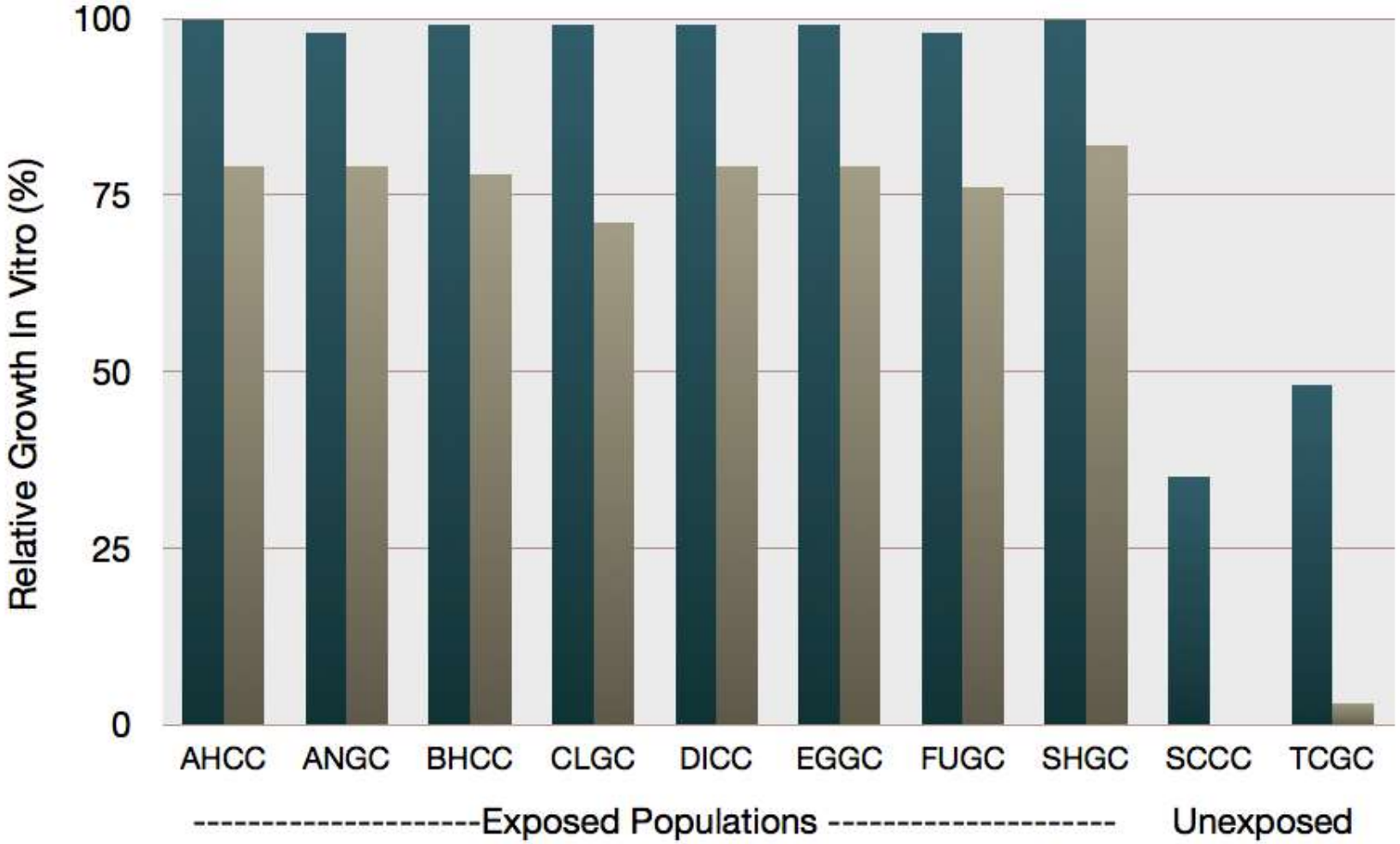
- single mutation in cytB gene

DMIs

- mechanisms unknown



QoI resistance is widespread in California populations of *C. cereale*



Wong et al. 2007. Plant Disease 91:1536.

G143A mutation in cytB in California populations of *C. cereale*

Isolate	130	140	150	160	170
TCCG-5.31 (sen)	LGYVLPYGQM	SLWGATVITN	TMSAIPWIGQ	DIVESVWGGF	SV
TCCG-5.33 (sen)	LGYVLPYGQM	SLWGATVITN	TMSAIPWIGQ	DIVESVWGGF	SV
TCGC-5.34 (sen)	LGYVLPYGQM	SLWGATVITN	TMSAIPWIGQ	DIVESVWGGF	SV
CLGC-11 (res)	LGYVLPYGQM	SLWAATVITN	TMSAIPWIGQ	DIVEFVWGGF	SV
CLGC-12 (res)	LGYVLPYGQM	SLWAATVITN	TMSAIPWIGQ	DIVEFVWGGF	SV
CLGC-13 (res)	LGYVLPYGQM	SLWAATVITN	TMSAIPWIGQ	DIVEFVWGGF	SV
EGGC-21 (res)	LGYVLPYGQM	SLWAATVITN	TMSAIPWIGQ	DIVEFVWGGF	SV
EGGC-22 (res)	LGYVLPYGQM	SLWAATVITN	TMSAIPWIGQ	DIVEFVWGGF	SV
EGGC-23 (res)	LGYVLPYGQM	SLCAATVITN	TMSAIPWIGQ	DIVEFVWGGF	SV
SHGC-26 (res)	LGYVLPYGQM	SLWAATVITN	TMSAIPWIGQ	DIVEFVWGGF	SV
SHGC-27 (res)	LGYVLPYGQM	SLWAATVITN	TMSAIPWIGQ	DIVEFVWGGF	SV
SHGC-28 (res)	LGYVLPYGQM	SLWAATVITN	TMSAIPWIGQ	DIVEFVWGGF	SV
AHCC-10 (res)	LGYVLPYGQM	SLWAATVITN	TMSAIPWIGQ	DIVEFVWGGF	SV
AHCC-11 (res)	LGYVLPYGQM	SLWAATVITN	TMSAIPWIGQ	DIVEFVWGGF	SV
AHCC-13 (res)	LGYVLPYGQM	SLWAATVITN	TMSAIPWIGQ	DIVEFVWGGF	SV
Cyt b (sen)	LGYVLPYGQM	SLWGATVITN	TMSAIPWIGQ	DIVESVWGGF	SV

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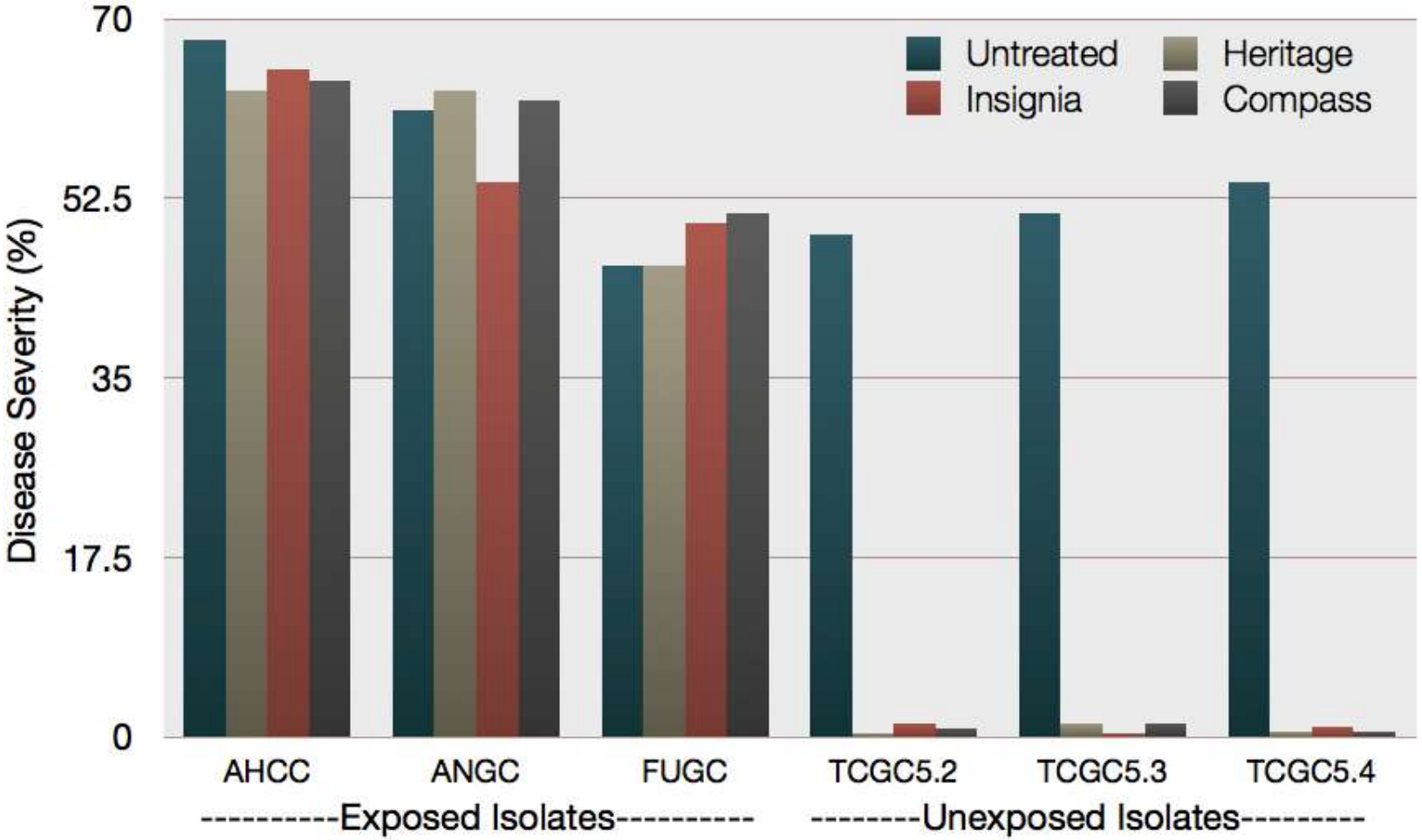
Wong et al. 2007. Plant Disease 91:1536.

G143A mutation in cytB yields complete resistance to all QoI fungicides



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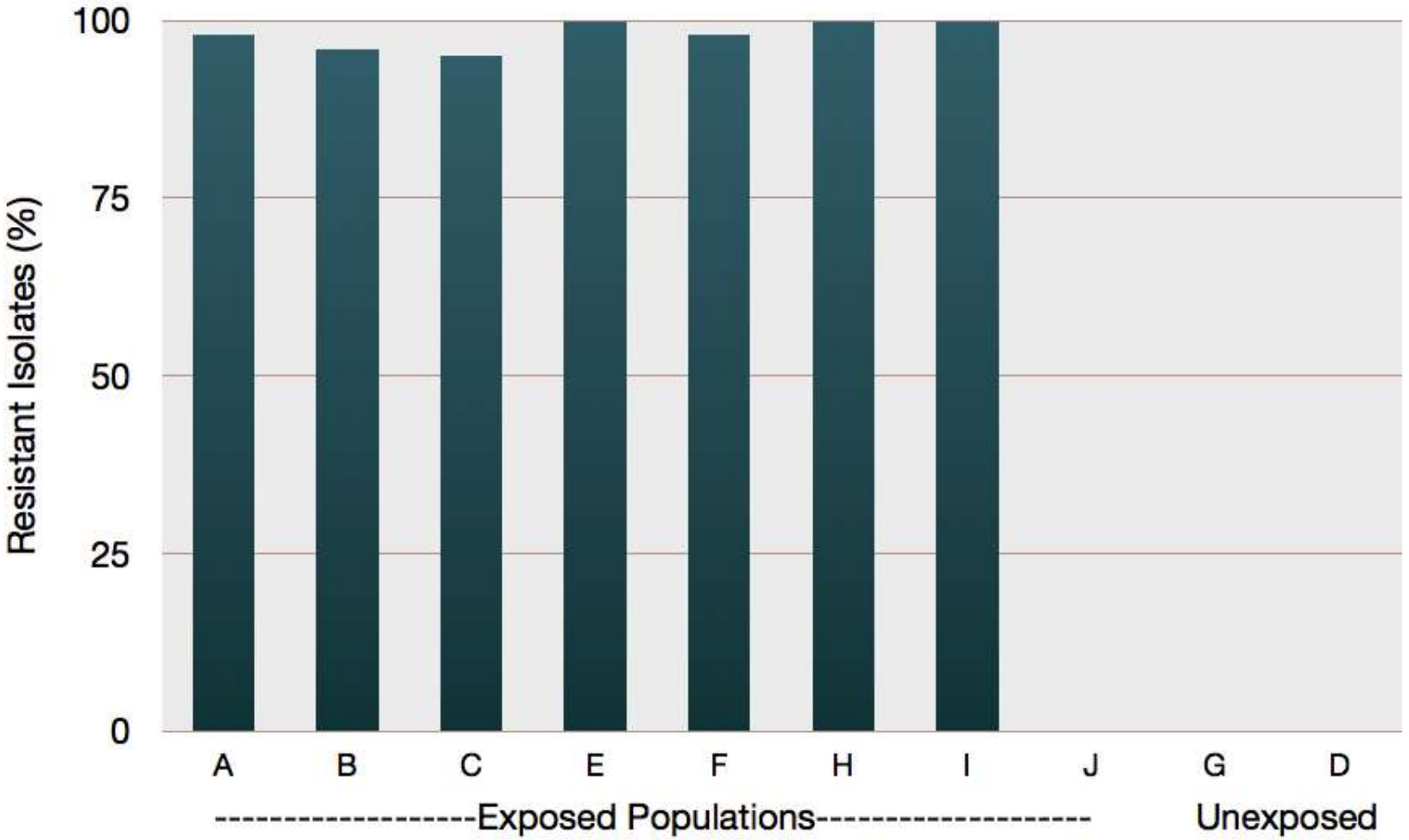
Wong et al. 2007. Plant Disease 91:1536.

Benzimidazole resistance is also widespread in California populations of *C. cereale*



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Wong and Midland. GCM. June 2004.

Distribution of QoI resistance in Southeast US populations

Location	Host	Sensitive (%)	Intermediate (%)	Resistant (%)
West Point, MS	bentgrass	0	0	100
Birmingham, AL	bentgrass	0	0	100
Birmingham, AL	bentgrass	0	0	100
Sylacauga, AL	bentgrass	0	0	100
West Point, MS	bentgrass	0	0	100
West Point, MS	bentgrass	0	0	100
Birmingham, AL	bentgrass	0	0	100
Inverness, AL	bentgrass	0	0	100
Olive Branch, M	bentgrass	0	0	100
Tupelo, MS	bentgrass	0	0	100
Tupelo, MS	bentgrass	0	0	100
Gatlinburg, TN	bentgrass	0	0	100
Leland, NC	bentgrass	0	0	100
Charlotte, NC	bentgrass	0	0	100
Sanford, NC	bentgrass	0	0	100
Monroe, NC	bentgrass	0	0	100
Virginia Beach, VA	bentgrass	0	0	100
Blowing Rock, NC	annual bluegrass	0	25	75
Starkville, MS	tall fescue	100	0	0
Asheville, NC	annual bluegrass	100	0	0

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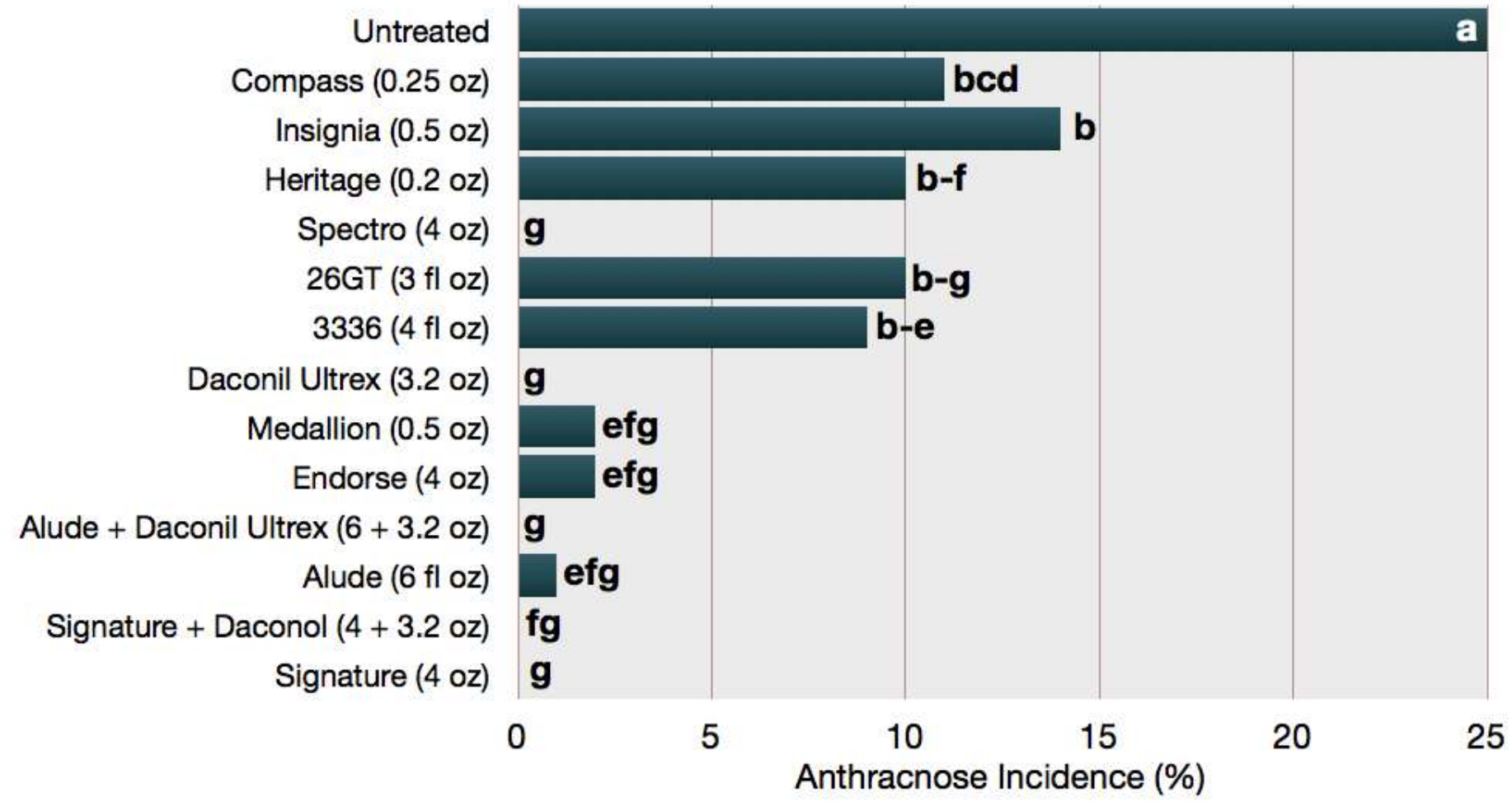
Young et al. 2010. Plant Disease 94:751.

Anthracnose Control in Annual Bluegrass
Blowing Rock Country Club, Blowing Rock NC



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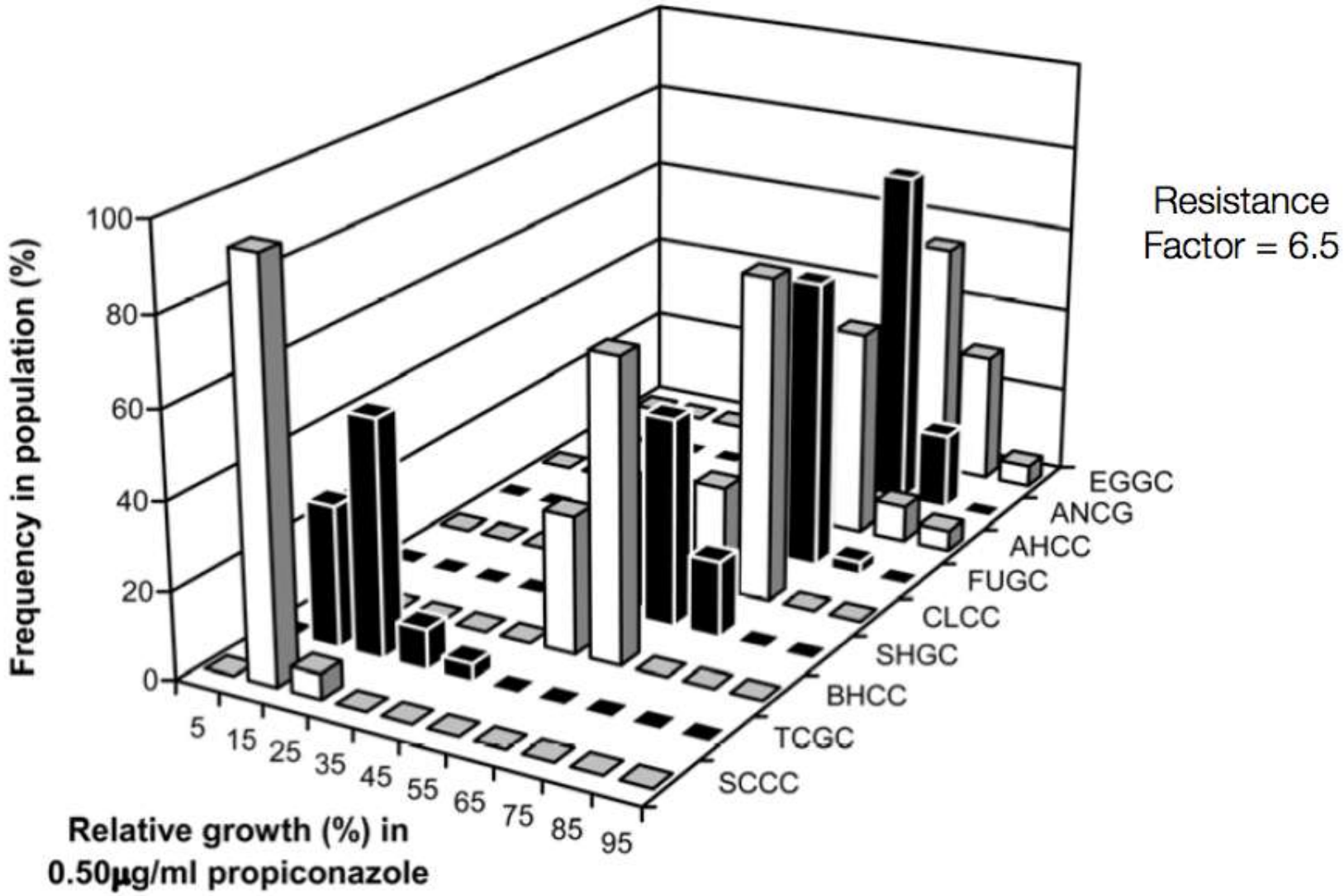
Treatments applied 5/23, 6/6, 6/20, 7/11, and 7/25
Data collected 8/15

Distribution of benzimidazole resistance in Southeast US populations of *Colletotrichum graminicola*

Location	Host	Sensitive (%)	Resistant (%)
West Point, MS	bentgrass	0	100
Birmingham, AL	bentgrass	0	100
Birmingham, AL	bentgrass	0	100
Sylacauga, AL	bentgrass	0	100
West Point, MS	bentgrass	0	100
West Point, MS	bentgrass	0	100
Birmingham, AL	bentgrass	0	100
Inverness, AL	bentgrass	0	100
Olive Branch, M	bentgrass	0	100
Tupelo, MS	bentgrass	0	100
Tupelo, MS	bentgrass	0	100
Gatlinburg, TN	bentgrass	0	100
Leland, NC	bentgrass	0	100
Charlotte, NC	bentgrass	0	100
Sanford, NC	bentgrass	0	100
Monroe, NC	bentgrass	0	100
Virginia Beach, VA	bentgrass	0	100
Blowing Rock, NC	annual bluegrass	0	100
Starkville, MS	tall fescue	100	0
Asheville, NC	annual bluegrass	100	0

Young et al. 2010. Plant Disease 94:751.

Reduced DMI sensitivity in California anthracnose populations



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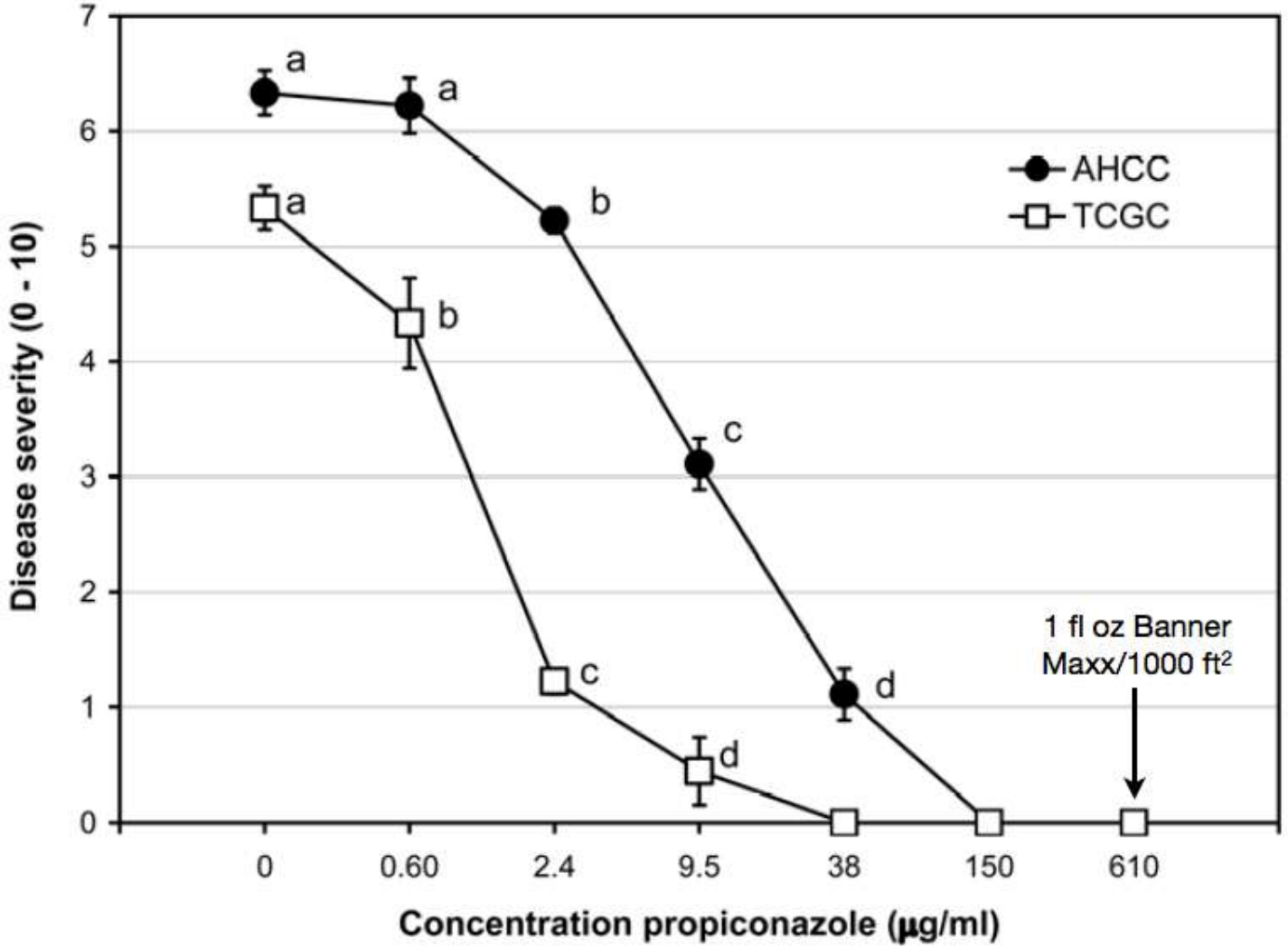
Wong et al. 2007. Plant Disease 91:1547.

Reduced efficacy of propiconazole at low rates as a result of reduced DMI sensitivity.



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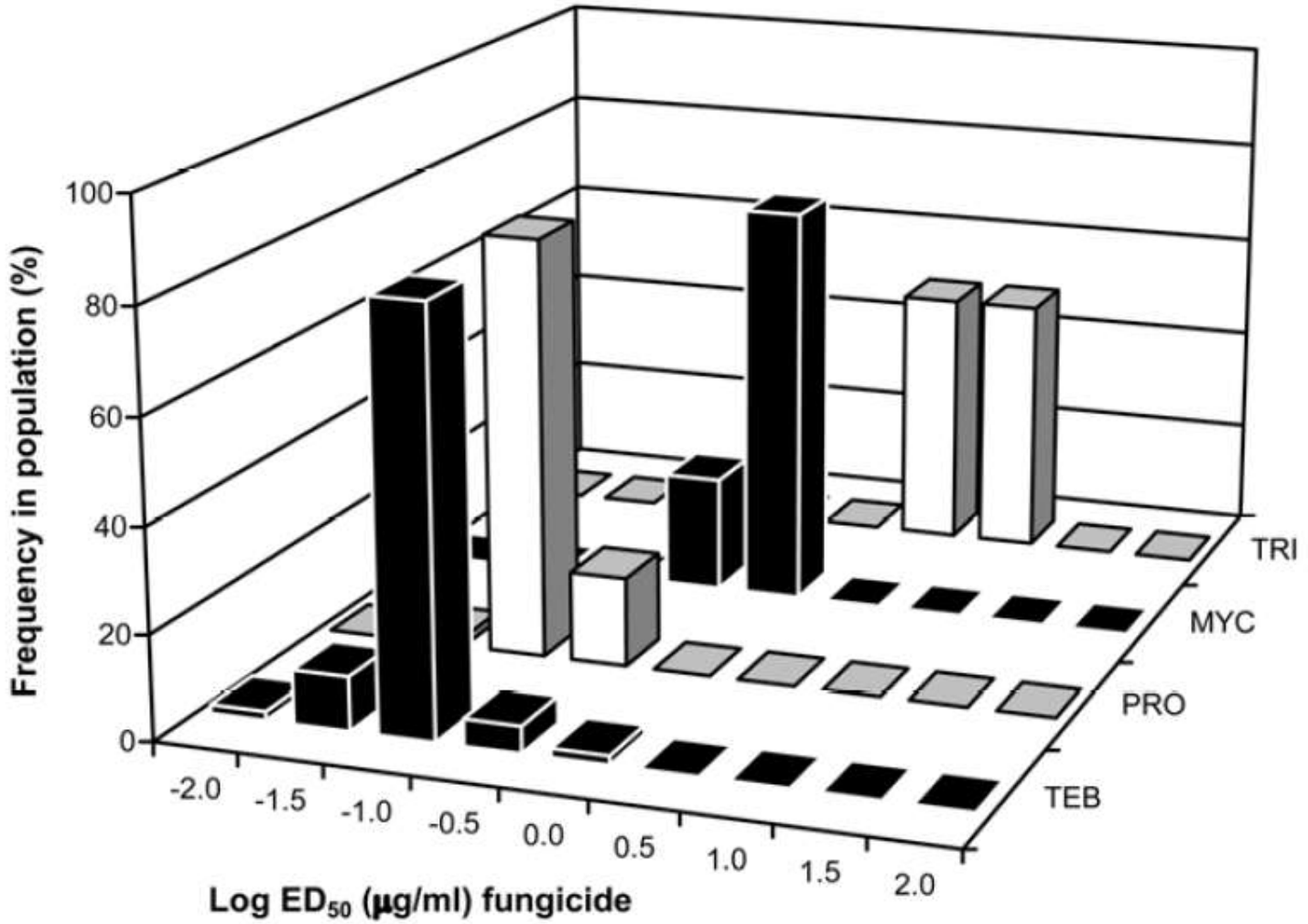
Wong et al. 2007. Plant Disease 91:1547.

DMI fungicides vary in their intrinsic activity against *C. cereale* (unexposed population TCGC)



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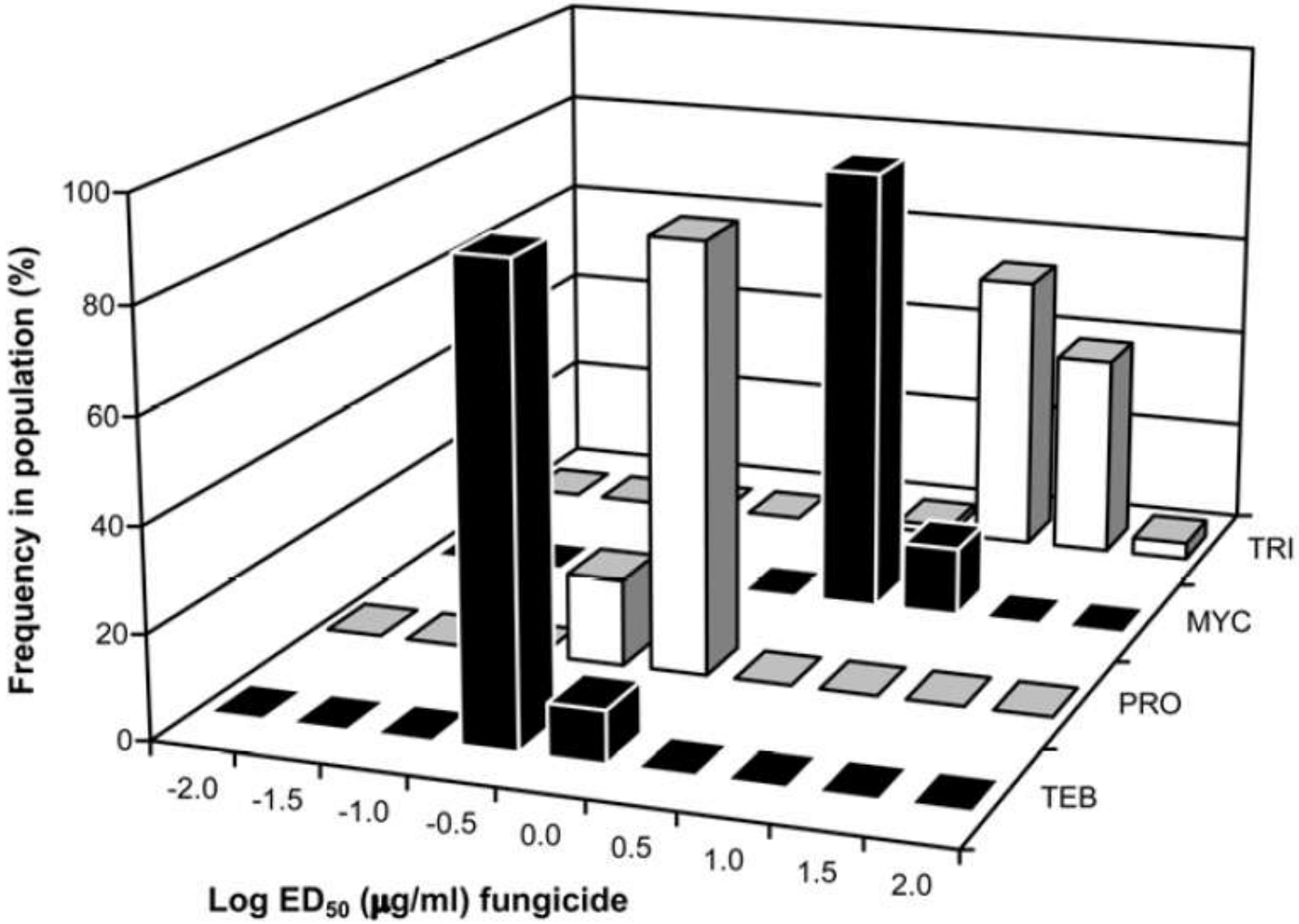
Wong et al. 2007. Plant Disease 91:1547.

DMI fungicides vary in their intrinsic activity against *C. cereale* (exposed population AHCC)



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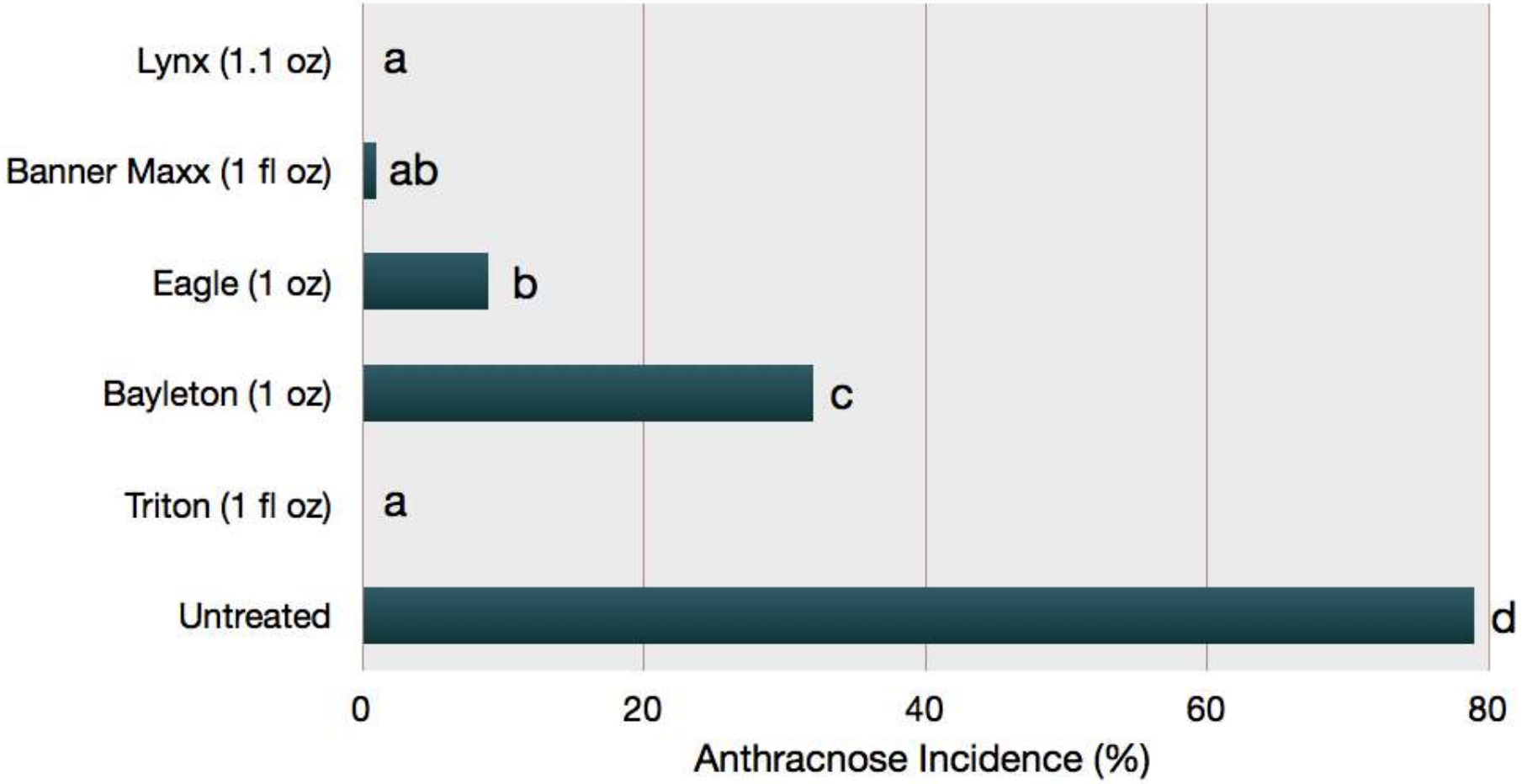
Wong et al. 2007. Plant Disease 91:1547.

Comparison of DMI fungicides for anthracnose control (Towers et al. 2003. PDMR 58:T017)



Treatments applied every 14-days beginning May 16
Data collected Aug 2

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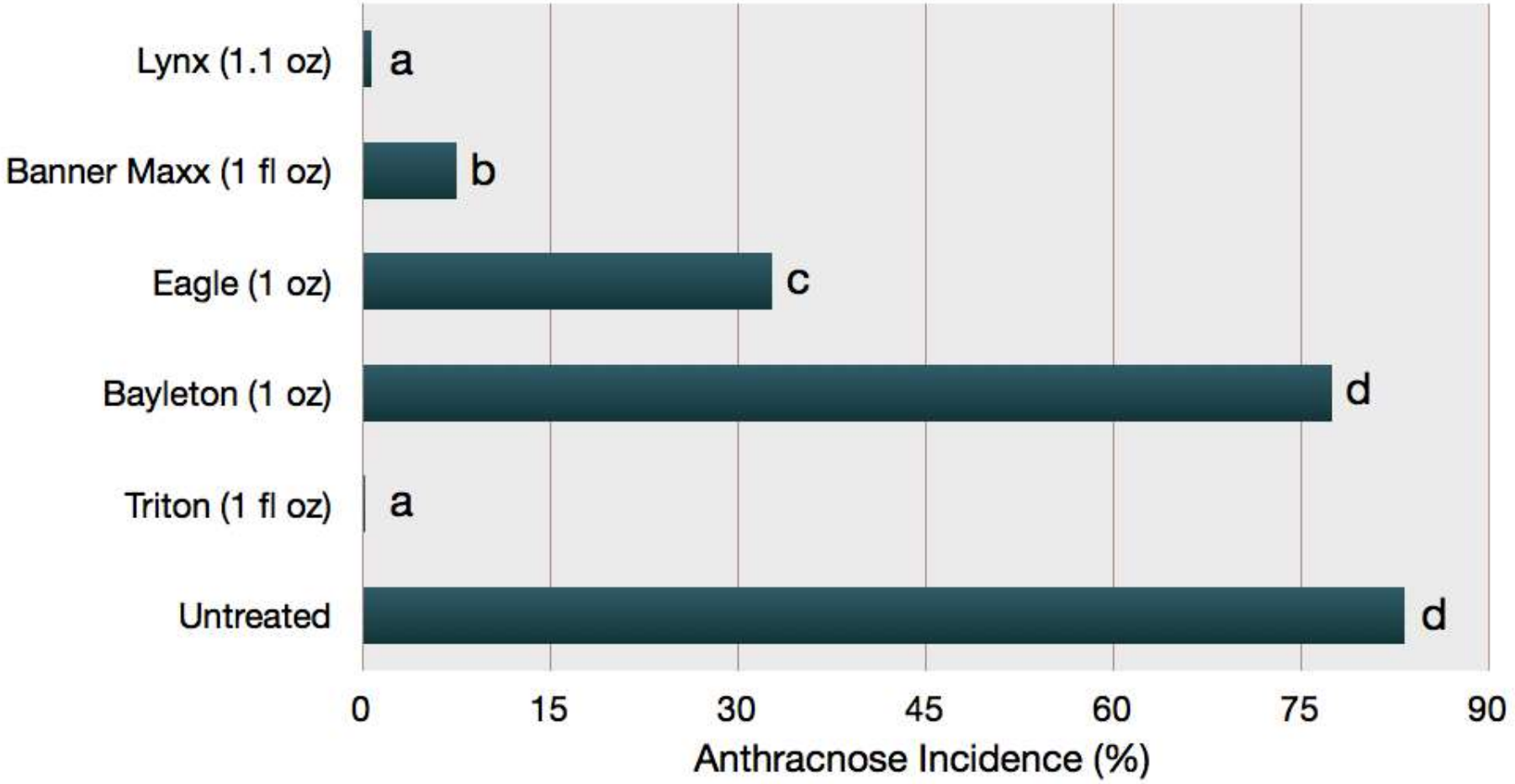
Comparison of DMI fungicides for anthracnose control (Towers et al. 2003. PDMR 58:T017)



Treatments applied every 14-days beginning May 16
Data collected Sept 10

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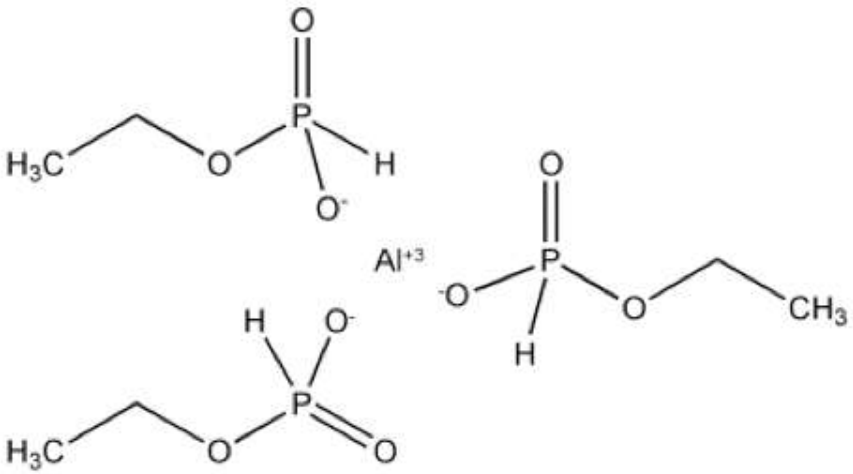
Phosphonate Fungicides for Turfgrasses

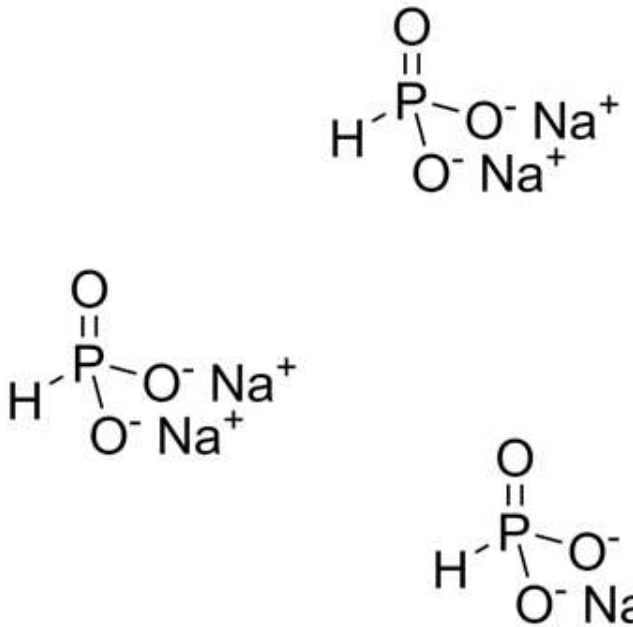
Phosphite Form	Trade Names
fosetyl-Al	Signature, Aliette, Autograph, Fosetyl-Al, Prodigy
mono- and di-potassium salts	Alude, Resyst, Vital
NH_4 and K salts	Magellan, Magnum

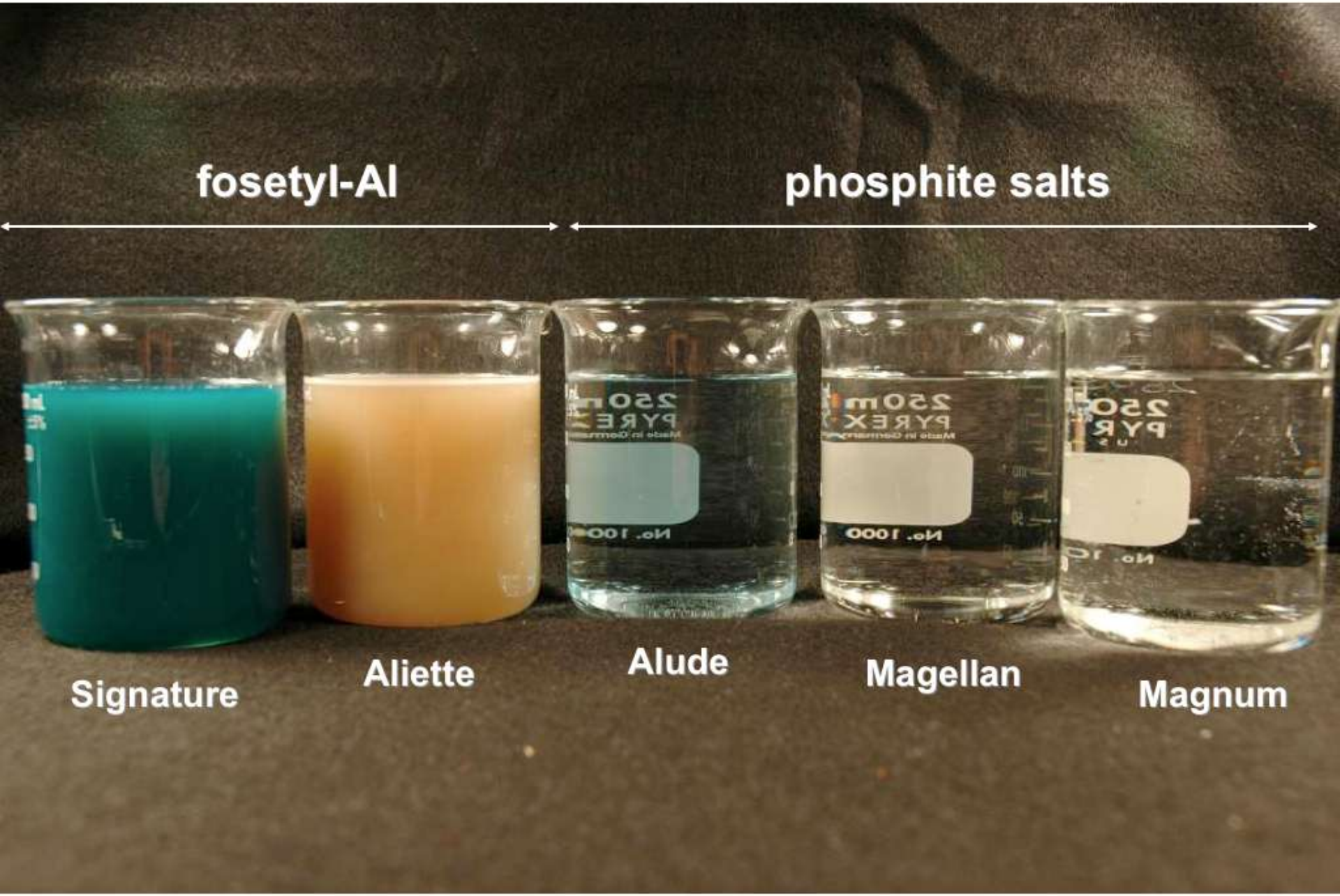
Phosphonate Fungicides for Turfgrasses

fosetyl-Al



phosphite salt





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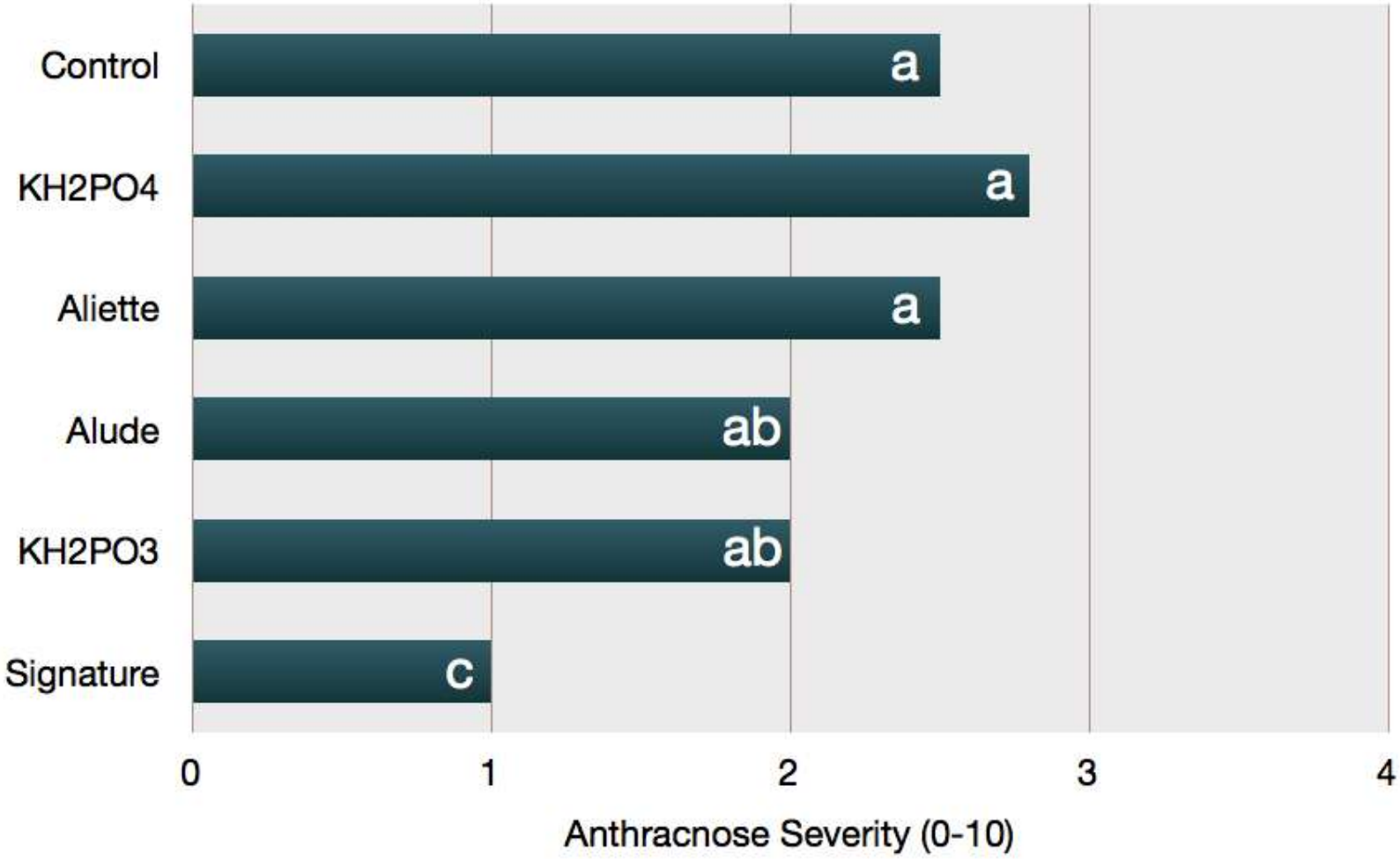
Comparison of phosphonate fungicides for anthracnose control on annual bluegrass (Cook and Landschoot)



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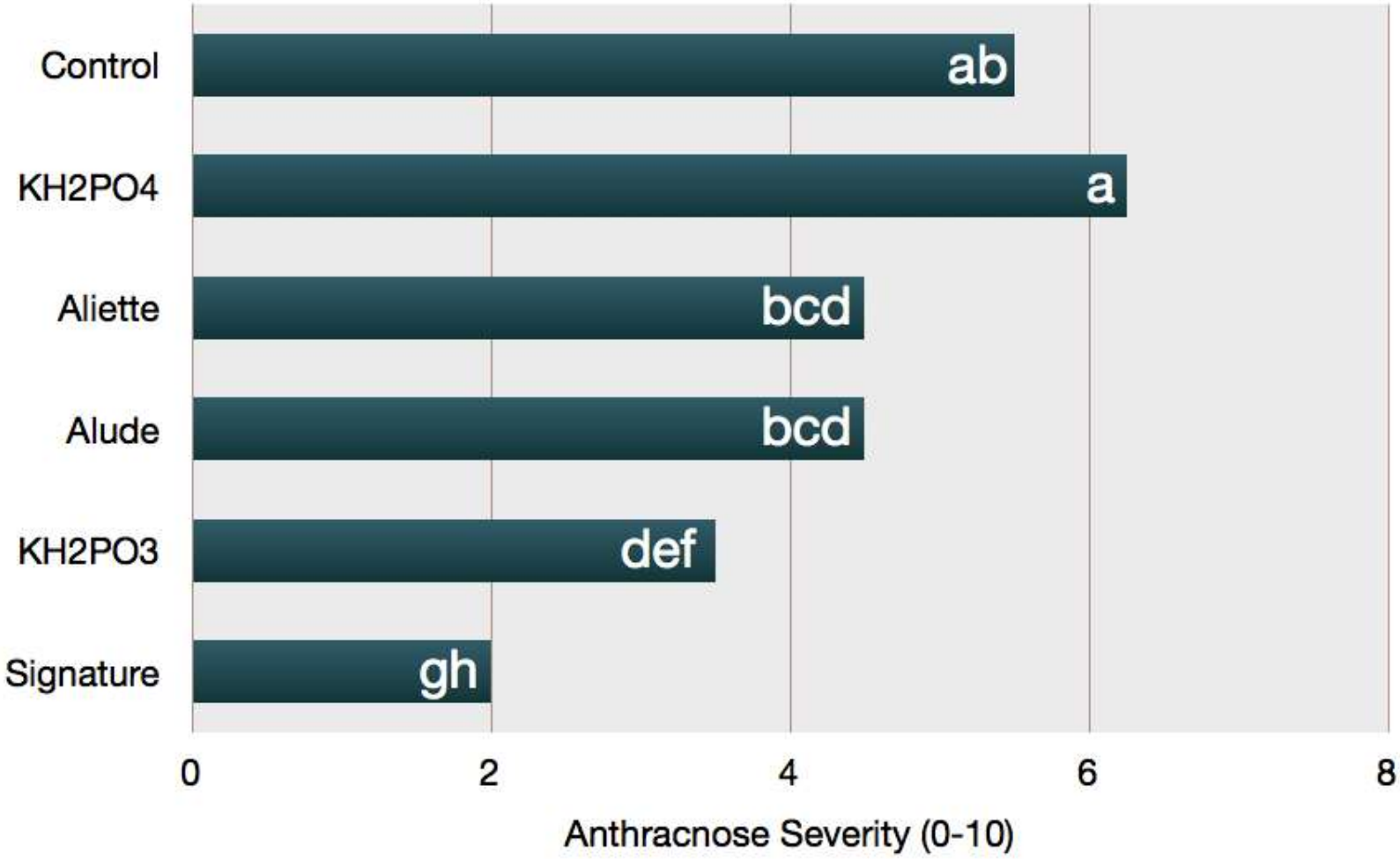
Data collected June 30 2004, following 4 applications on 14-day interval

Comparison of phosphonate fungicides for anthracnose control on annual bluegrass (Cook and Landschoot)



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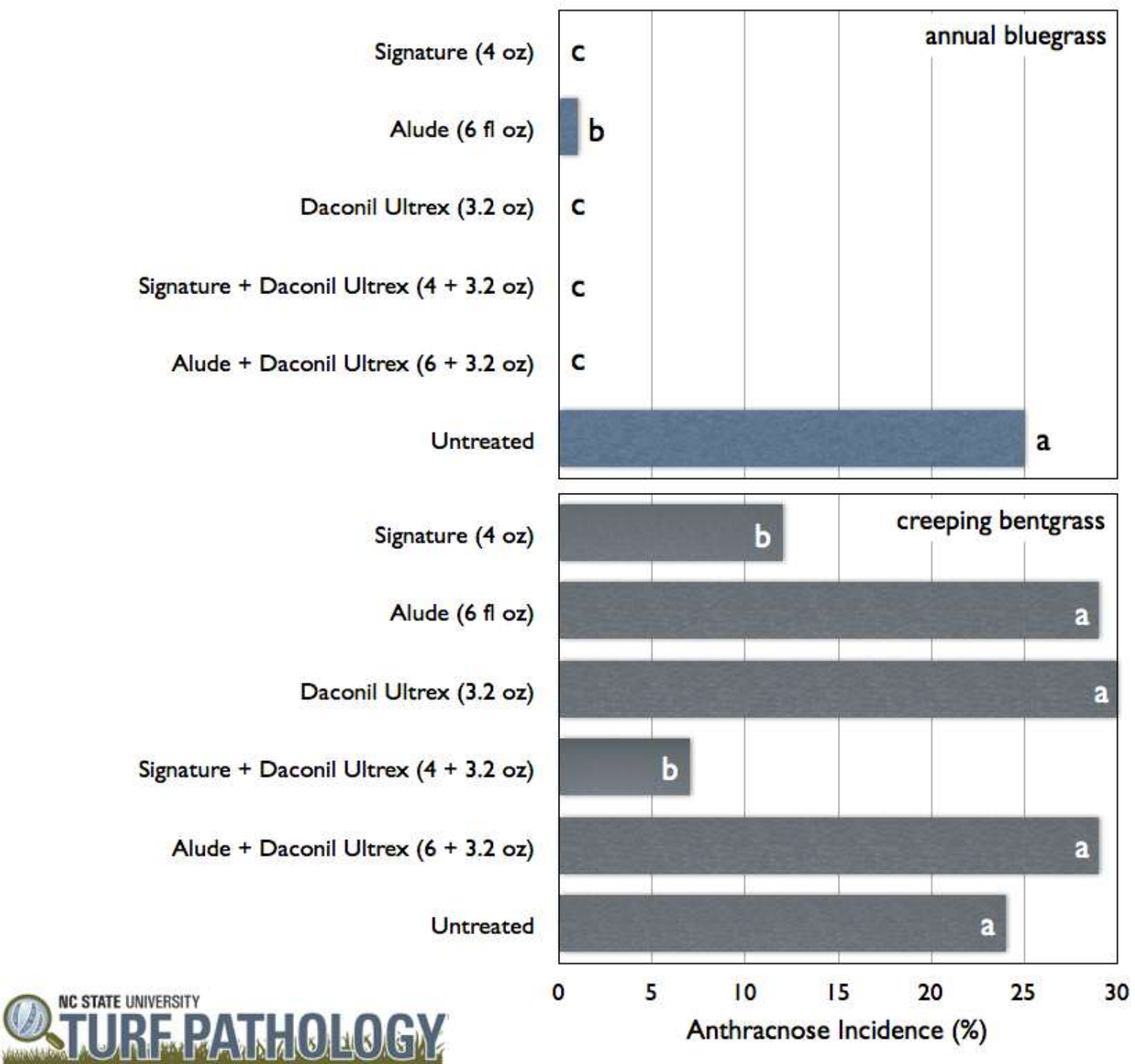
Data collected July 5 2005, following 5 applications on 14-day interval



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Active ingredients providing acceptable control in field trials

2006 (NJ)	2006 (CA)	2007 (NJ)	2007 (CT)	2008 (NJ)	2009 (CA)
chlorothalonil	polyoxin D	chlorothalonil	chlorothalonil	chlorothalonil	propiconazole
fludioxonil	fludioxonil	tebuconazole	fludioxonil + fosetyl-Al	metconazole	metconazole
fosetyl-Al	fosetyl-Al + chlorothalonil		tebuconazole	tebuconazole	tebuconazole
polyoxin D	fosetyl-Al + iprodione			tebuconazole + fosetyl-Al	triticonazole
propiconazole				triticonazole	
tebuconazole					

New products for anthracnose management

Civitas

- mineral oil + pigment

Daconil Action

- chlorothalonil + the plant activator acibenzolar

Velista

- penthiopyrad (SDHI class of chemistry)

Summary: Anthracnose Management with Fungicides

- resistance to the benzimidazole and QoI fungicides is widespread in *C. cereale*
- reduced sensitivity to DMIs has been detected but probably not leading to control failures
- DMIs vary in their intrinsic activity against *C. cereale*: metconazole, propiconazole, tebuconazole, and triticonazole are most effective
- phosphonate fungicides vary in their effectiveness from trial to trial, but the performance of fosetyl-Al is most consistent
- few single products provide acceptable anthracnose control; rotations and tank-mixtures are most effective