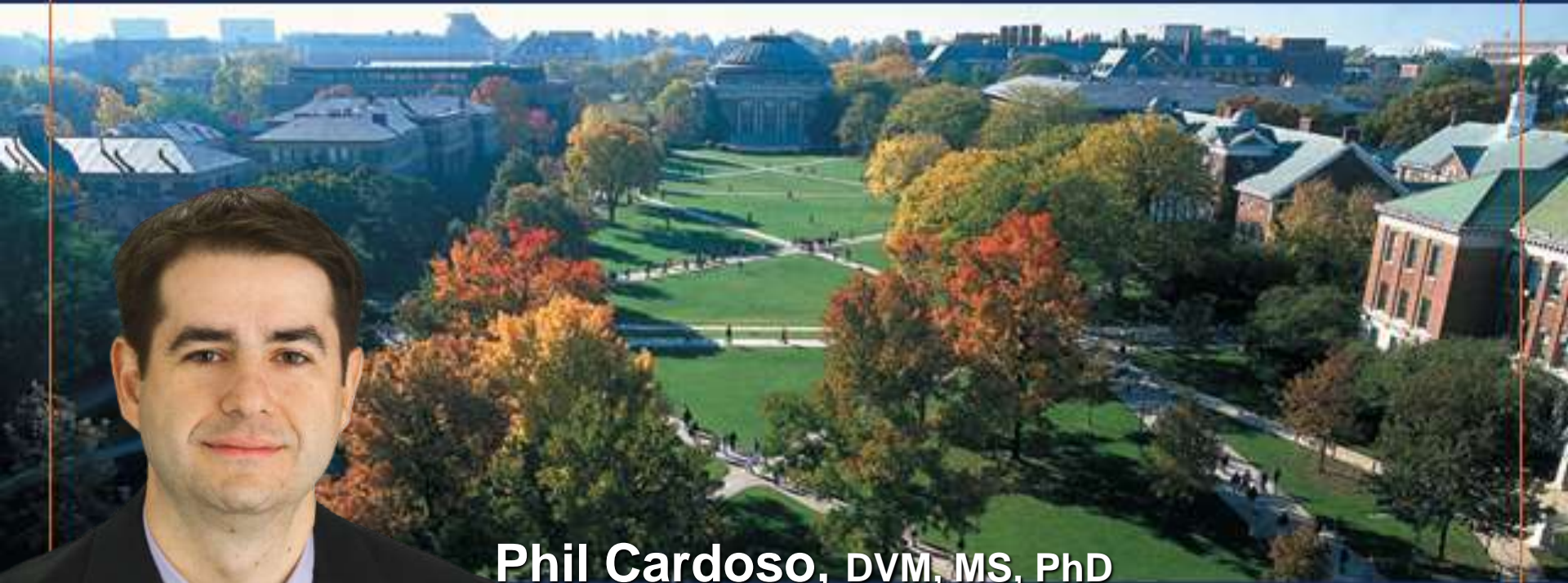


Corn Silage Mycotoxins... and more

Dairy Forage Seminar

October 5th, 2018

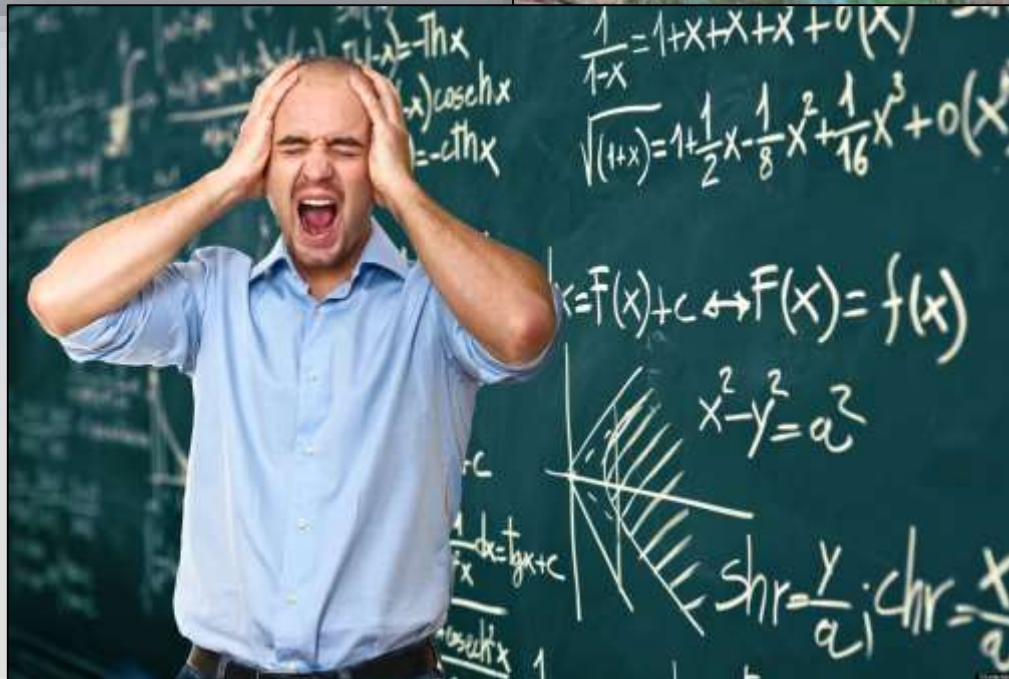
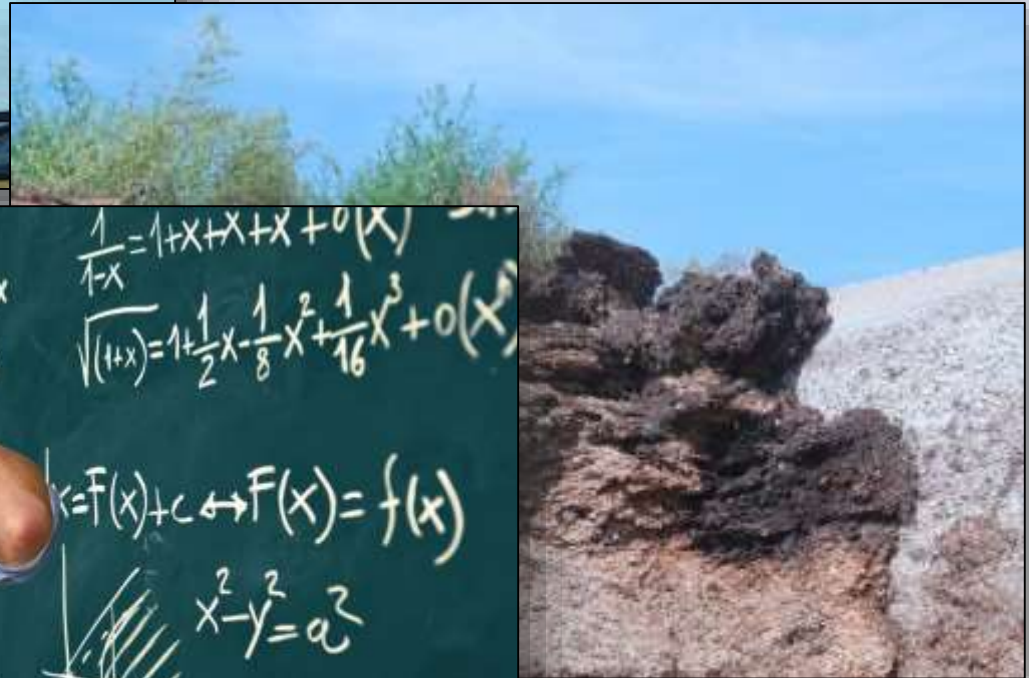


Phil Cardoso, DVM, MS, PhD



UNIVERSITY OF **ILLINOIS**
AT URBANA-CHAMPAIGN





Corn Silage Numbers...

- NASS estimated that in 2014:
 - 89.4% of dairy farms incorporated CS in diets
 - 14% of total corn production → CS

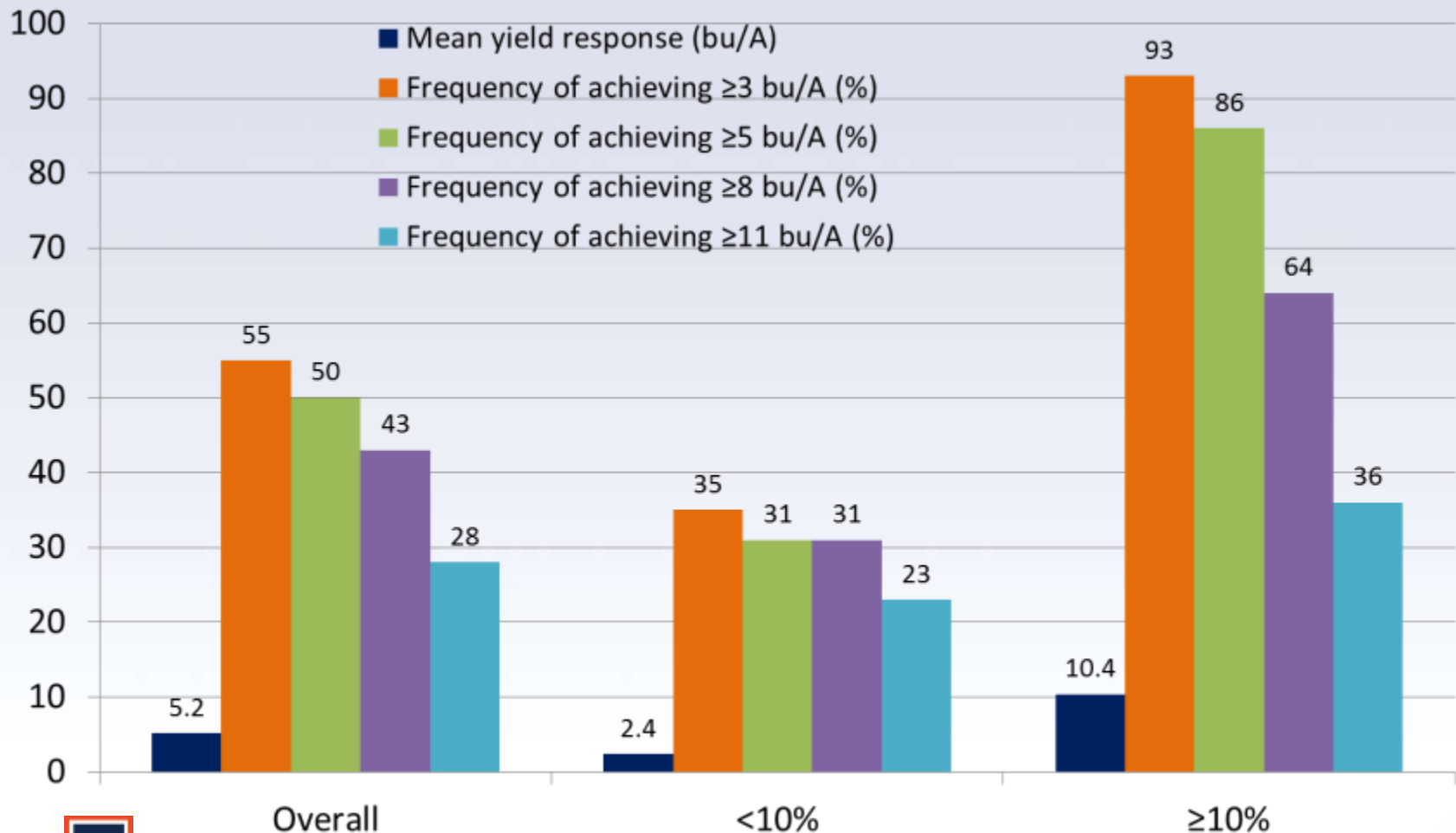


Corn Silage Quality

- Planting practices
 - Planting date, population, row spacing, **disease control**
- Fertility management
 - Crop rotation, soil management
- **Hybrids**
 - Yield potential, forage quality
- Harvesting
 - Moisture, additives, processing, **cut height**
- Storage
 - Bunker, plastic, holes



Fungicide Use in Corn: Plant Yield Effect



Final Disease Severity in Non-treated Control



Key Forage Quality Factors

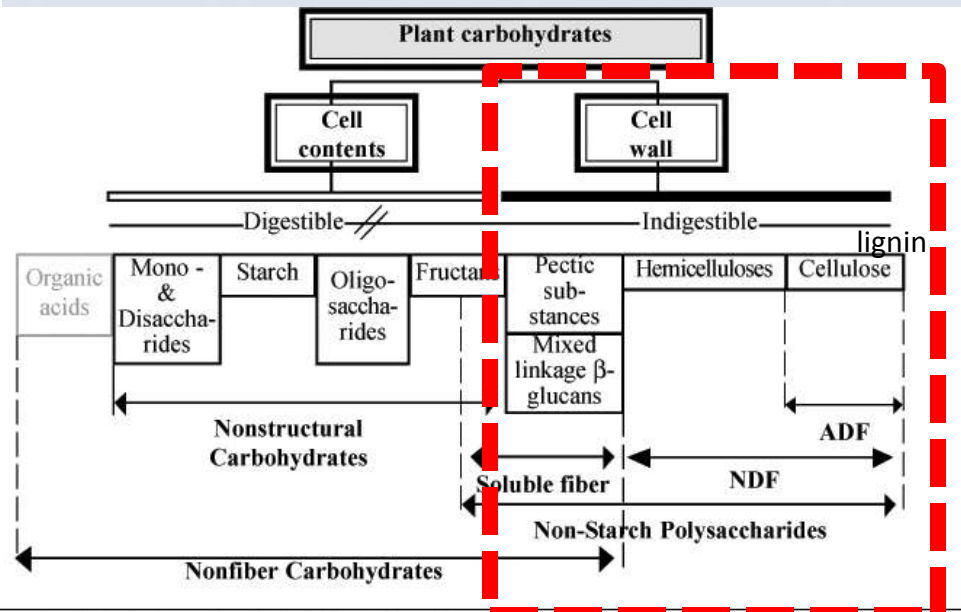
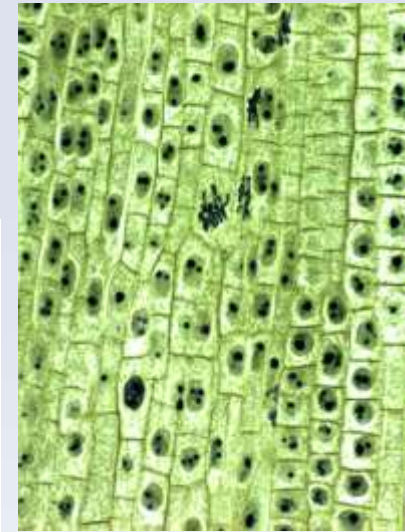
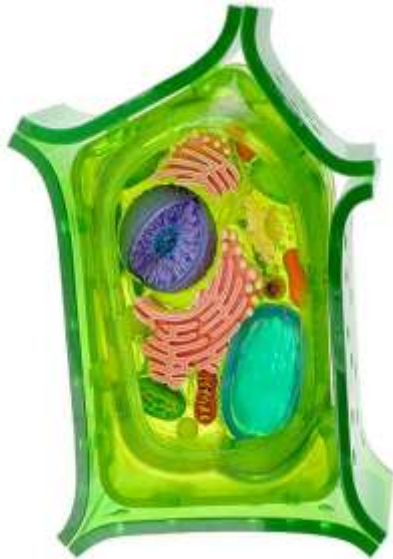


Figure 1 - Carbohydrates in plants. *Digestible or Indigestible* refer to potential for digestion by enzymes in the small intestine; all carbohydrates shown are potentially fermentable. Organic acids are not a carbohydrate, but their mass is included in the nonfiber carbohydrate value that is calculated by difference. As shown, soluble fiber includes only non-starch polysaccharides not in NDF. NDF = neutral detergent fiber, ADF = acid detergent fiber.

Cell wall fraction makes up
approximately 40% of corn silage

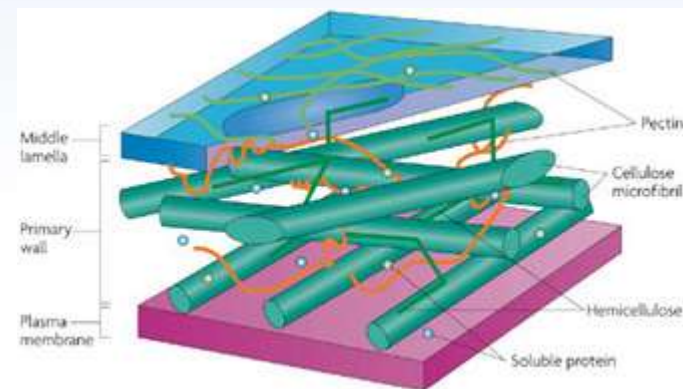
Key Forage Quality Factors

NDF

- Cellulose, hemicellulose, lignin
- Going from low to high NDFD can increase milk 11 lb/d (Grant et al, 1995)
- Plant stress can cause more lignin content and decrease NDFD (Yates et al., 1997)
 - Cold stress
 - Drought stress
 - Infection stress

ADF

- Cellulose, lignin
- Related to plant cell wall digestibility
- Negative correlation between ADF and DMI (Van Soest, 1965)
- Negative correlation with *in vitro* NDFD (Allen et al, 2003)



Other Forage Quality Factors

- Mycotoxins

- Produced by secondary metabolism of (Keller et al., 2013):

- *Aspergillus* (Aflatoxin; Ochratoxin A (OTA); Citrinin)
 - *Penicillium* (Cyclopiazonic acid (CPA); Citrinin)
 - *Fusarium* (Fumonisin; Zearalenone; Deoxynivalenol=Vomitoxin; T-2)



- Field disease scoring for infection may not be adequate to determine mycotoxin content (Eckard et al., 2011)
 - Common rust (*Puccinia triticina*)
 - Grey leaf spot (*Cercospora zeae-maydis*)
 - Northern leaf blight (*Exserohilum turcicum*)
 - Can lead to loss of nutrients, dry matter, and palatability, can also decrease rumen function and decrease reproductive performance (Scudamore & Livesy, 1998)



Mycotoxins in Corn Silage (2017)

Mycotoxin	Total samples (n)	Positive samples (n)	Positive samples (%)	Average \pm 1 STDEV
Aflatoxin ,ppb	3,380	426	12.6	10 – 8.5
Zearalenone ,ppb	3,380	652	19.3	330 – 320
Vomitoxin ,ppm	3,380	2,286	67.6	2.6 – 2.9
Fumonisin ,ppm	3,380	11	0.3	4.6 – 3.5
T-2 ,ppm	3,380	135	4.0	110 – 248

Summary of combined 2017, multi-lab (DairyOne, Dairyland Lab, and AnaLab) data



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Potentially harmful toxin concentrations for a total diet (DM)

	Dairy	Feedlot	Swine	Poultry	Equine
Toxin	Values listed in blue are PPM, all other listed in PPB				
Aflatoxin	20	20	20	20	20
Deoxynivalenol (DON or Vomitoxin)*	0.5 to 1.0	10	1	2	500
Fumonisin	2	7	10	20	500
T-2 Toxin	100	500	100	100	NA
Zearalenone	400	5	300	10	50
Ochratoxin	5	5	700	700	35
Ergot toxins (combined)	500	500	500	750	300



Corn Varieties Fungus in Corn – Scout!

The screenshot shows a web page from the University of Wisconsin Extension's Field Crops Pathology section. The article, dated July 13, 2015, is written by Damien L. Smith, an Extension Field Crops Pathologist. It discusses the challenges of scouting for corn diseases in 2015, specifically focusing on Northern Corn Leaf Blight (NCLB) and the decision of whether to spray fungicides. The page includes a header with navigation links, a sidebar with contact information and a subscribe form, and two figures: a close-up of NCLB lesions on a corn leaf (Figure 1) and a computer simulation of NCLB severity (Figure 2).

WISCONSIN FIELD CROPS PATHOLOGY

Home | Info | Corn | Soybean | Wheat | Variety Trials | Fungicide Information | Fact Sheets | Videos | Summaries | About Us | Links

Corn Diseases of 2015 and Should I Spray Fungicide?

Posted on July 13, 2015 by [damien.smith](#)

Damen L. Smith, Extension Field Crops Pathologist, University of Wisconsin

The phone has been ringing a lot lately and the primary questions are:

- What corn diseases should I be concerned with this year in Wisconsin?
- Should I spray a fungicide? And if so, what product and timing?

Let's start with the first question. As far as foliar disease issue, I think we need to scout closely for northern corn leaf blight (NCLB) in Wisconsin. The Midwest is already seeing high levels of this disease and it is showing up in the lower canopy in corn fields in southern Wisconsin. Remember, that this disease can be easily confused with Gea's wilt. Earlier this season I wrote a post about differentiating these two diseases. I encourage you to [visit that post on a re-reader](#). In addition to NCLB, our scouting has revealed a second foliar disease present in the lower and mid-canopy of the corn crop. That second disease is eyespot. Let's talk about NCLB and eyespot in a little greater detail.




Figure 1. NCLB lesions on a corn leaf

Northern Corn Leaf Blight (NCLB): The most diagnostic symptom of NCLB is the long, slender, cigar-shaped, gray-green to tan lesions that develop on leaves (Fig. 1). Disease often begins on the lower leaves and works its way to the top leaves. This disease is favored by cool, wet, rainy weather, which has seemed to dominate lately. Higher levels of disease might be expected in fields with a previous history of NCLB and/or fields that have been in continuous and no-till corn production. The pathogen over-winters in corn residue, therefore, the more residue on the soil surface the higher the risk for NCLB. Management should focus on using resistant hybrids and residue management. In-season management is available in the form of several fungicides that are labeled for NCLB. However, these fungicides should be applied at the early onset of the disease and only if the epidemic is expected to get worse.

While I hate talking about threshold levels for managing diseases, it can be helpful in your decision making process to know what might be severe. While scouting look in the lower portion of the canopy. If some symptoms are present in the lower canopy, make a visual estimation of how frequent (percentage of plants with lesions) NCLB is in a particular area and how severe (how much leaf area is covered by NCLB lesions). The lower leaves aren't responsible for much yield accumulation in corn, but spores produced in NCLB lesions on these leaves can be splashed up to the ear leaves where disease can be very impactful. So by scouting the lower canopy and getting an idea of how much disease is present, you can "predict" what might happen later on the ear leaves to make an informed spray decision. The other consideration you should make while scouting is the resistance rating that the hybrid has for NCLB. If it is rated as resistant, then NCLB severity might not be predicted to get very severe, while in a susceptible hybrid, NCLB might be present on 50% or more of plants at high severity levels. Note however, that even if a hybrid is rated as resistant, it can still get some disease. Research has shown that NCLB is resistant on one of every half the plants and susceptible on leaves 8-10.

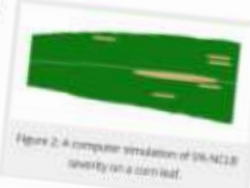


Figure 2. A computer simulation of 5% NCLB severity on a corn leaf.

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UPCOMING EVENTS

None at this time

WISCONSIN CROP MANAGER

2018 Wisconsin Field Crops Pathology Fungicide Tests Summary December 23, 2015



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<http://fyi.uwex.edu/fieldcroppathology/2015/07/13/corn-diseases-of-2015-and-should-i-spray/>





J. Dairy Sci. 98:8962–8972

<http://dx.doi.org/10.3168/jds.2015-9887>

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Corn silage from corn treated with foliar fungicide and performance of Holstein cows

K. J. Haerr,* N. M. Lopes,*† M. N. Pereira,† G. M. Fellows,‡ and F. C. Cardoso*¹

*Department of Animal Sciences, University of Illinois, Urbana 61801

†Departamento de Zootecnia, Universidade Federal de Lavras, Lavras, MG, Brazil 37200-000

‡BASF Corporation, Research Triangle Park, NC 27709

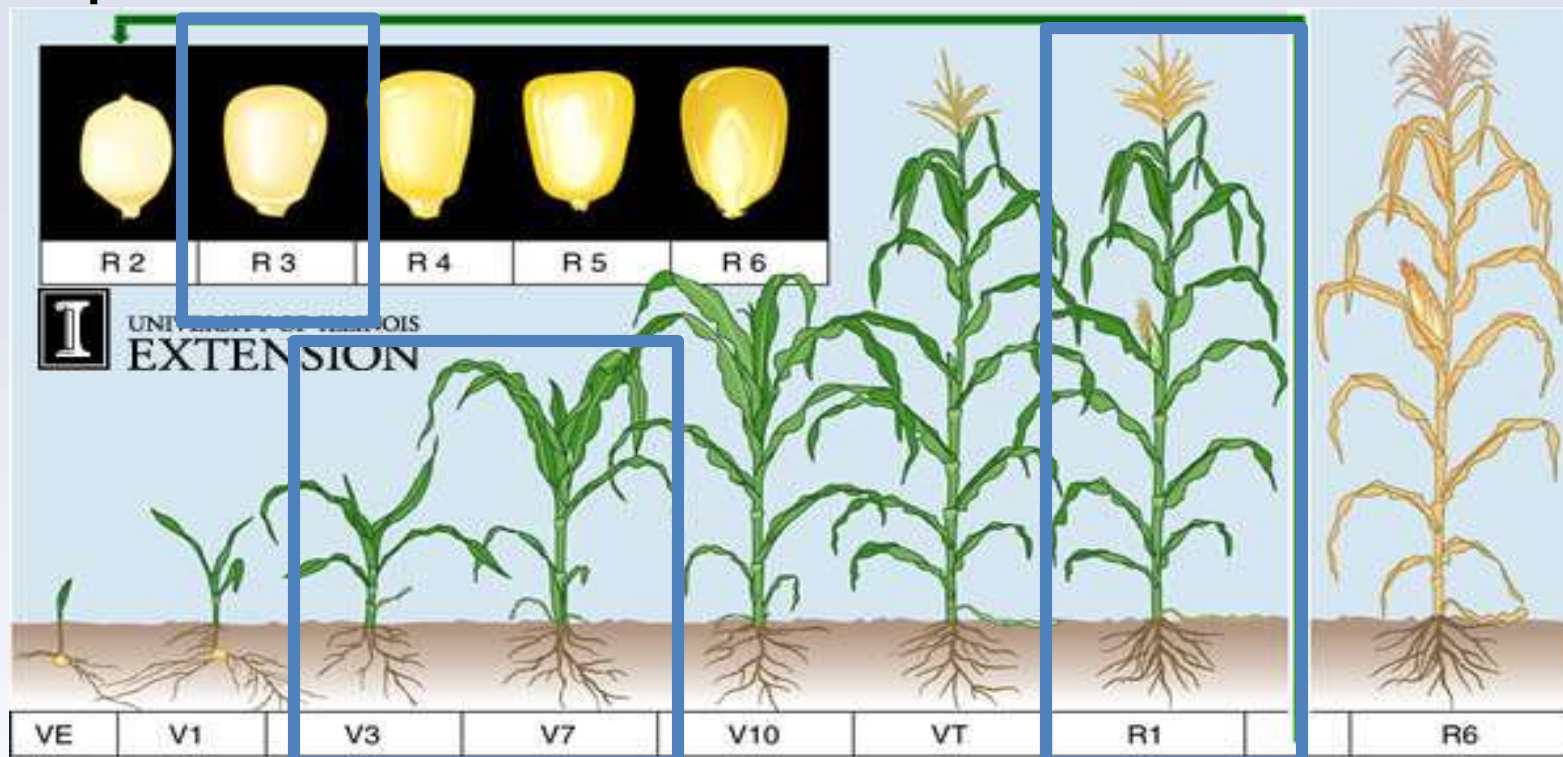


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Materials and Methods

- 4 Treatments



CON: No
Applications of
foliar fungicide

1X: 1 Application of
Headline® at V5

2X: 1 Application of
Headline® at V5, 1
Application of
Headline® AMP at R1

3X: 1 Application of
Headline® at V5, 1
Application of
Headline® AMP at R1
and R3



Active ingredient in Headline®: Pyraclostrobin

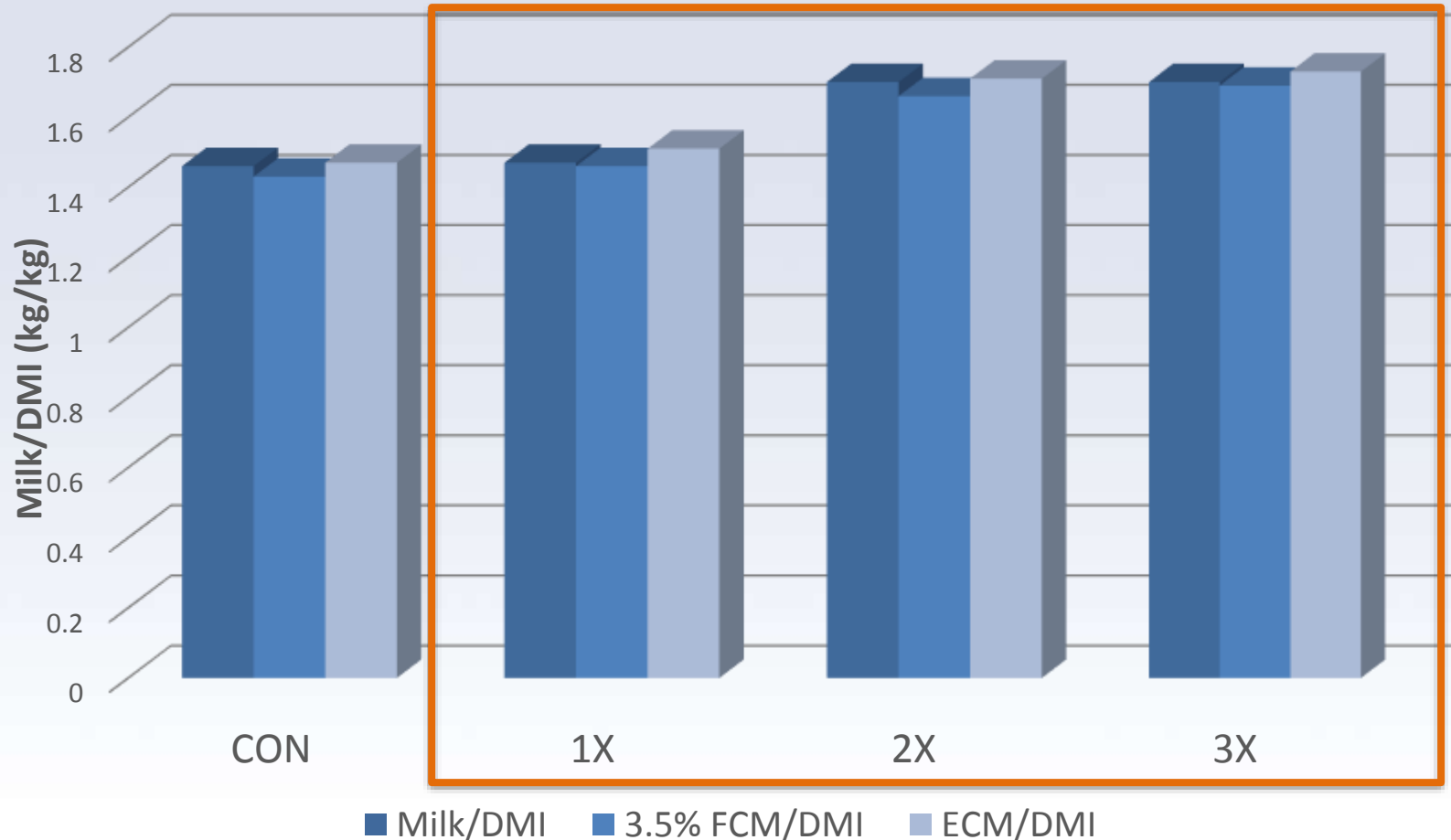
Headline® AMP: Pyraclostrobin + Metconazole

Corn silage yield did not change

- No symptoms of foliar disease
- Yield
 - CON: 61.12 Mg/ha or 9 tons/ acre (DM)
 - 1X: 59.70 Mg/ha or 8.0 tons/ acre (DM)
 - 2X: 63.99 Mg/ha or 9.2 tons/ acre (DM)
 - 3X: 61.22 Mg/ha or 9 tons/ acre (DM)



Feed efficiency increased with fungicide application

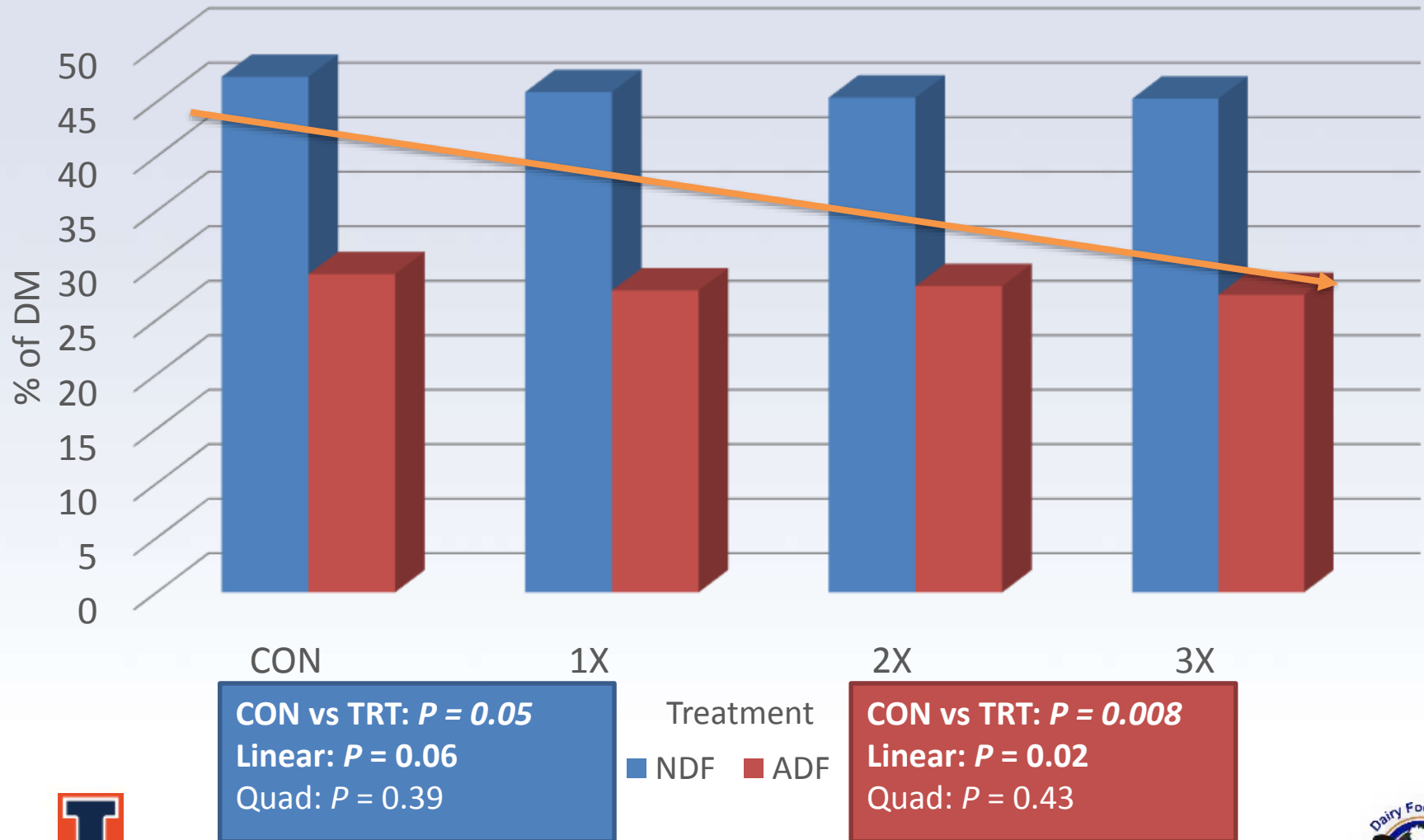


CON vs TRT: $P = 0.14$
Linear: $P = 0.03$
Quad: $P = 0.95$

CON vs TRT: $P = 0.09$
Linear: $P = 0.01$
Quad: $P = 0.94$

CON vs TRT: $P = 0.08$
Linear: $P = 0.02$
Quad: $P = 0.99$

Fiber content decreases as amount of applications increase

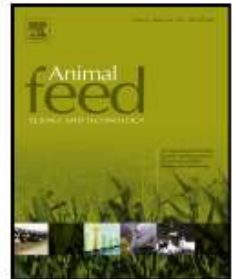




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Research Paper

Effects of corn treated with foliar fungicide on in situ corn silage degradability in Holstein cows



K.J. Haerr^a, A. Pineda^a, N.M. Lopes^{a,b}, J.D. Weems^c, C.A. Bradley^c, M.N. Pereira^b,
M.R. Murphy^a, G.M. Fellows^d, F.C. Cardoso^{a,*}

^a Department of Animal Sciences, University of Illinois, Urbana, IL 61801, USA

^b Departamento de Zootecnia, Universidade Federal de Lavras, Lavras, MG 37200-000, Brazil

^c Department of Crop Sciences, University of Illinois, Urbana, IL 61801, USA

^d B.A.S.F. Corporation, Research Triangle Park, NC 27709, USA

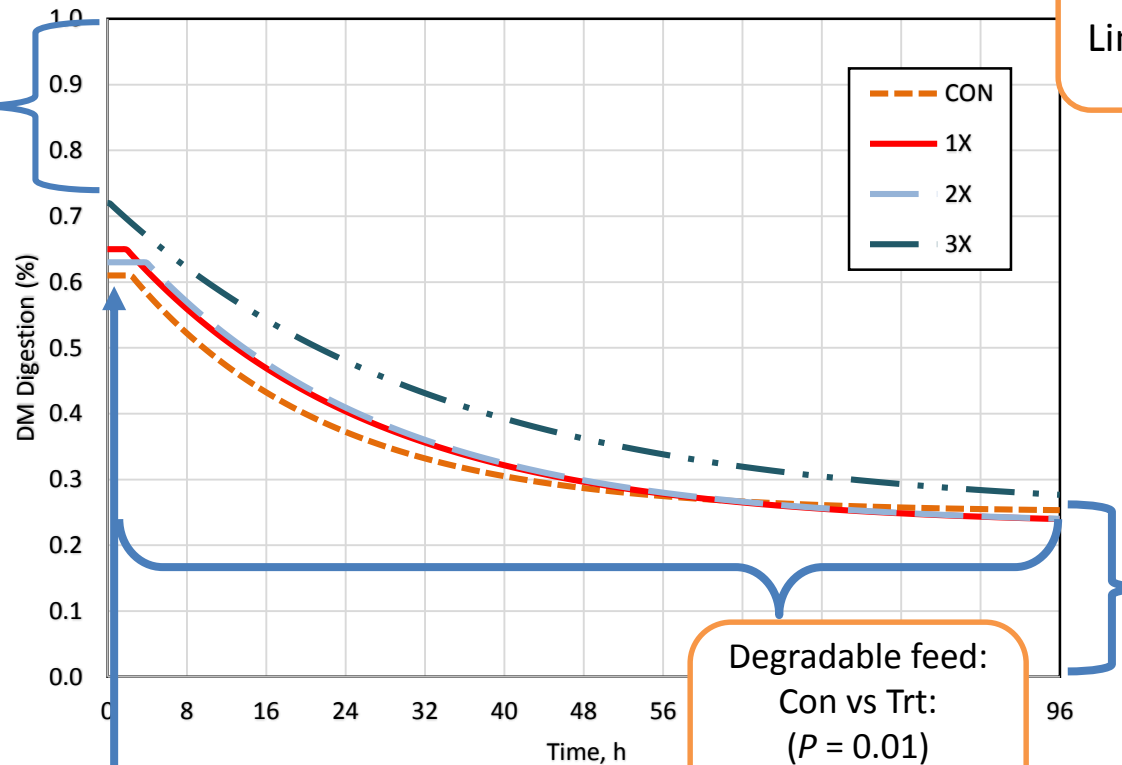


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Dry matter degradability is increased with fungicide application

Soluble feed:
Linear effect
($P = 0.04$)



K_d :
Linear effect: ($P = 0.04$)

Undegradable feed:
Non significant

Degradable feed:
Con vs Trt:
($P = 0.01$)
Linear effect:
($P = 0.006$)

Lag:
Non significant



Economic Considerations



Getty



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MILK 2006 Predictions

<http://shaverlab.dysci.wisc.edu/spreadsheets>

- Developed by the University of Wisconsin
 - Relative quality of a forage based on energy value which is predicted from ADF, and potential intake using NDF and NDFD.

	Milk Per Ton			Milk per Acre		
Treatment	Estimated	Calculated	Difference	Estimated	Calculated	Difference
CON	2952	2898	-53	26567	26090	-476
1X	3010	3006	-4	24062	24050	-11
2X	3016	3506	490	27563	31907	4344
3X	3057	3222	165	27540	28996	1456



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Cost of Fungicide

- Cost of fungicide per acre
 - 1X: \$ 30.00
 - 2X: \$ 60.00
 - 3X: \$ 90.00
- Cost per pound of silage
 - CON: \$ 0.044
 - 1X: \$ 0.046
 - 2X: \$ 0.047
 - 3X: \$ 0.049



It seems to pay off...



Income over feed cost (IOFC)*

	\$/lb DM	Feed Cost (consumed)	Milk Income	IOFC*
CON	\$ 0.121	\$ 6.30	\$ 13.65	\$ 7.34
1X	\$ 0.121	\$ 6.11	\$ 13.66	\$ 7.54
2X	\$ 0.122	\$ 5.23	\$ 13.54	\$ 8.31
3X	\$ 0.122	\$ 5.79	\$ 13.62	\$ 7.83



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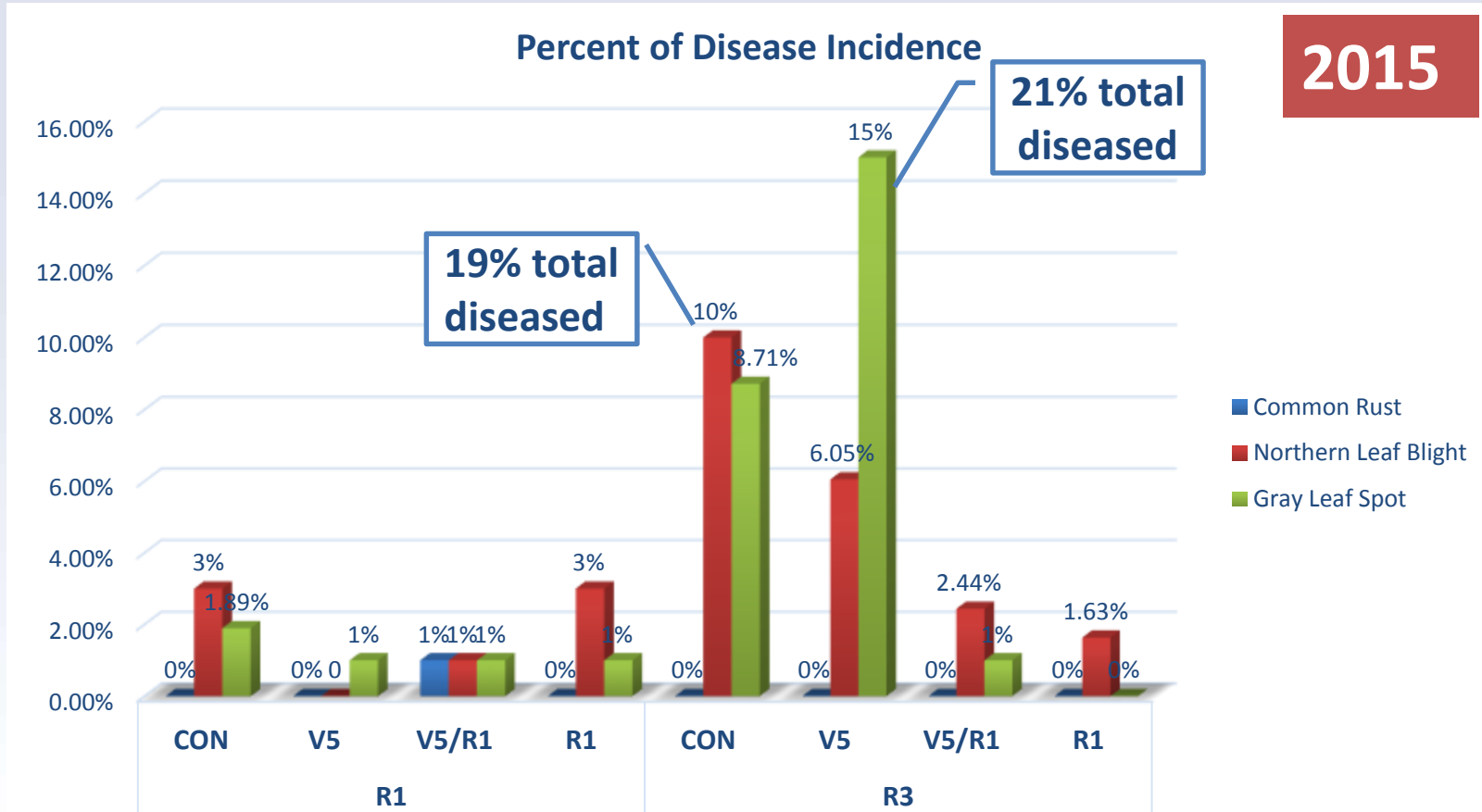


CON vs TRT: \$ 7.34 vs \$7.89



* Income over feed cost calculated as IOFC= milk income - total feed cost

Fungus in Corn



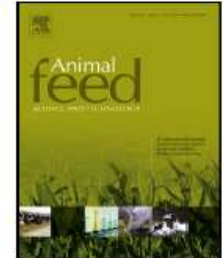


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Foliar fungicide (pyraclostrobin) application effects on plant composition of a silage variety corn



C.C. Kalebich^a, M.E. Weatherly^a, K.N. Robinson^a, G.M. Fellows^b, M.R. Murphy^a,
F.C. Cardoso^{a,*}

^a Department of Animal Sciences, University of Illinois, Urbana, IL 61801, USA

^b B.A.S.F. Corporation, Research Triangle Park, NC 27709, USA



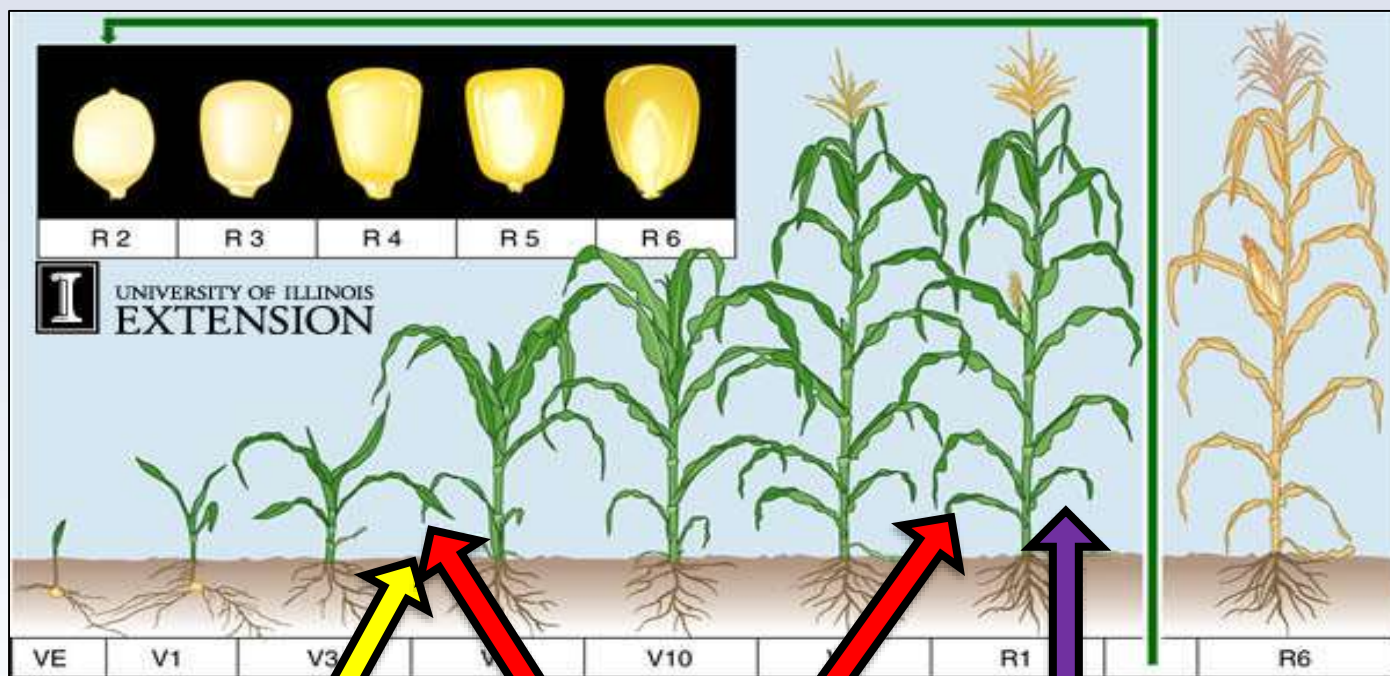
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Material and Methods

During summer 2015:

4 Treatments



CON: no application of fungicide

V5: one application of Priaxor[®] at V5

V5+R1: one application of Priaxor[®] at V5 and one of Headline AMP[®] application at R1

R1: one application of Headline AMP[®] at R1

Active Ingredient in Priaxor[®] : Pyraclostobin + Fluxapyroxad

Active Ingredient in Headline AMP[®] : Pyraclostobin + Metaconazole



Material and Methods

- Corn:
 - Seed: 1417 AMXRR, Pioneer
 - Type: Silage
 - Planted: April 30, 2015 at 32,000 plants/acre
 - Disease Evaluation:
 - July 11, 2015 – R1
 - August 13, 2015 – R3
 - Removed stalks from field at R1 and R3
 - July 12, 2015 – R1
 - August 18, 2015 – R3



Plant parts collected

**Collection at each R1
and R3**

Sampling as full plant:

- Weight of full plant
- Height of full plant
- Number of leaves
- Number of green leaves
- Number of yellow leaves



1. Flag Leaf

- Composit

2. Leaves

- Composit

3. Ears = cobs + kernels

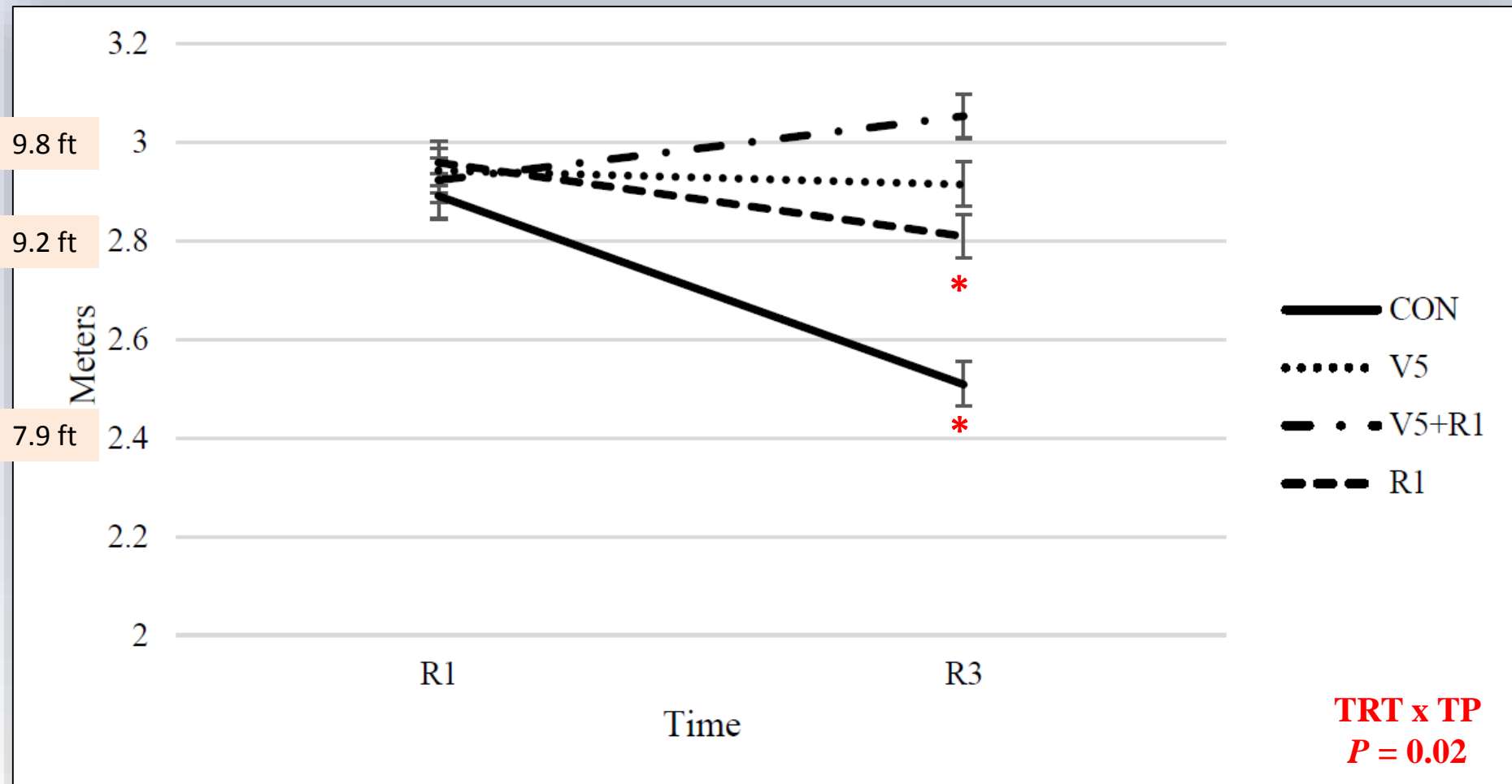
- Weight of ears
- Composit

4. Stalks

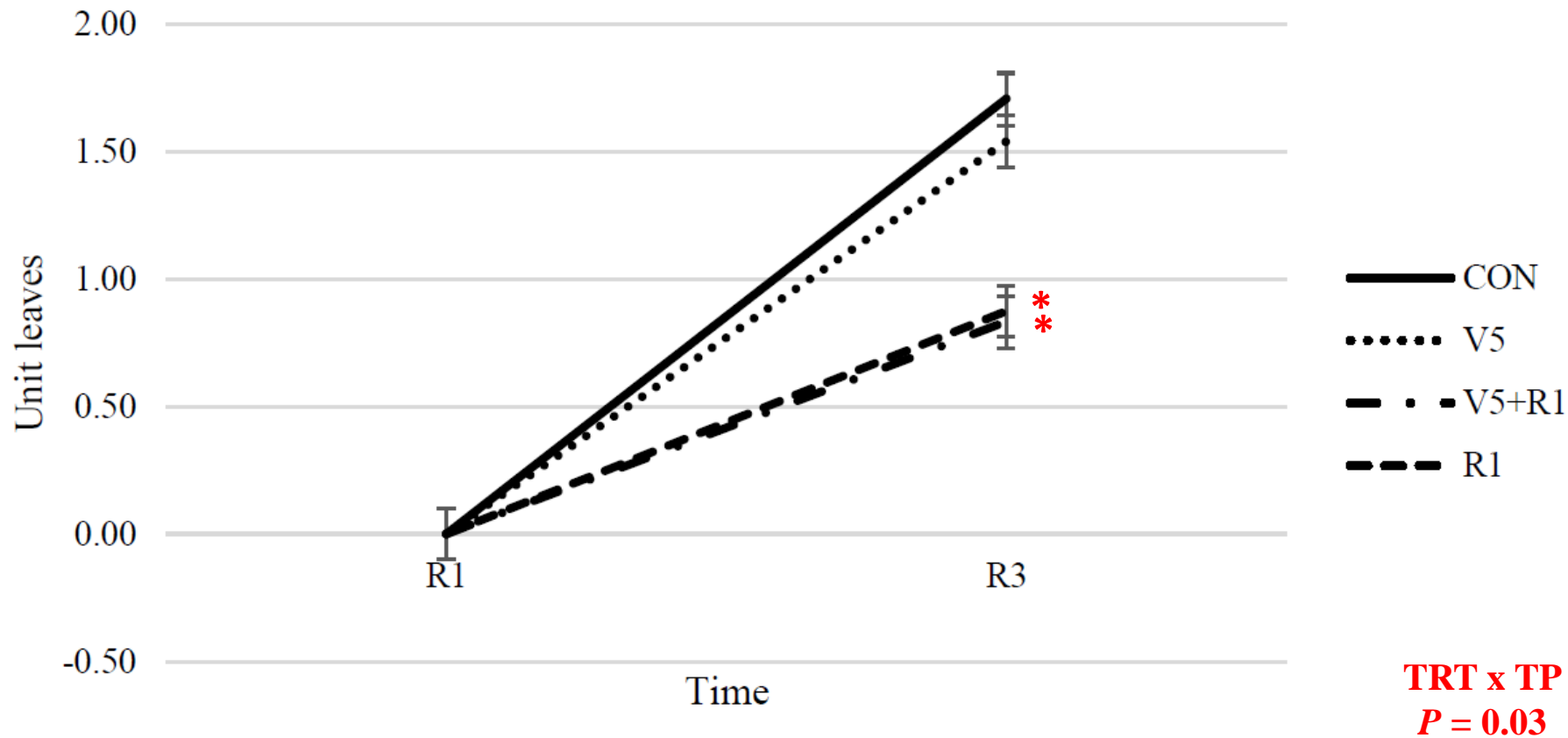
- Composit



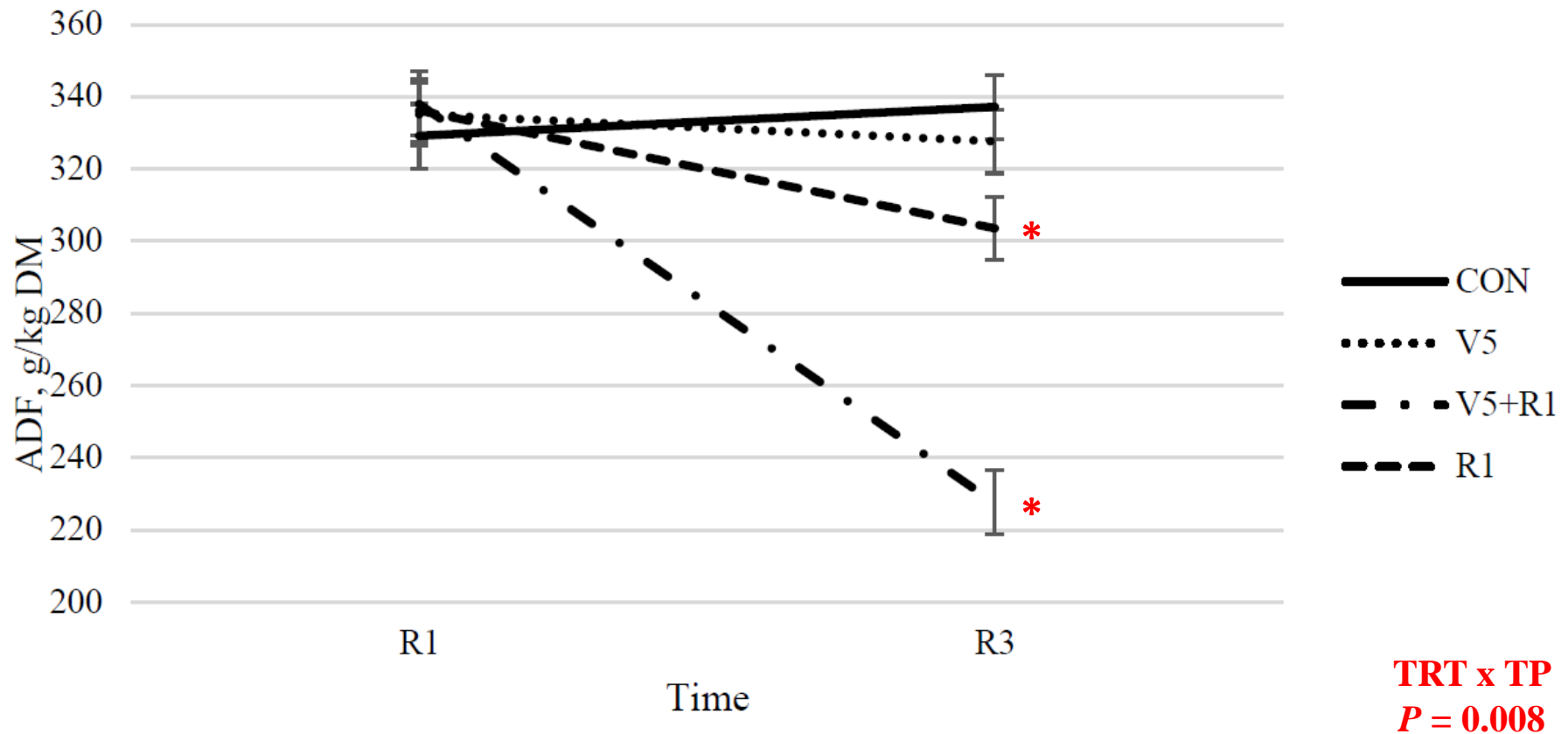
Height of corn stalk



Number of yellow leaves



Leaves fiber content



Corn Plant Conclusions

- Applications of fungicide on corn resulted in
 - Less yellow leaves
 - Taller plants
- Applications at both V5 and R1
 - Reduced NDF and ADF content in leaves
 - Increased lignin in stalks
- Implication:
 - Fungicide on corn may reduce stress impacts from disease and reduce the fibrous content in the leaves, while improving stalk strength





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Foliar fungicide (pyraclostrobin) application on corn and its effects on corn silage composition



C.C. Kalebich^a, M.E. Weatherly^a, K.N. Robinson^a, G.M. Fellows^b, M.R. Murphy^a,
F.C. Cardoso^{b,*}

^a Department of Animal Sciences, University of Illinois, Urbana, IL, 61801, USA

^b B.A.S.F. Corporation, Research Triangle Park, NC 27709, USA



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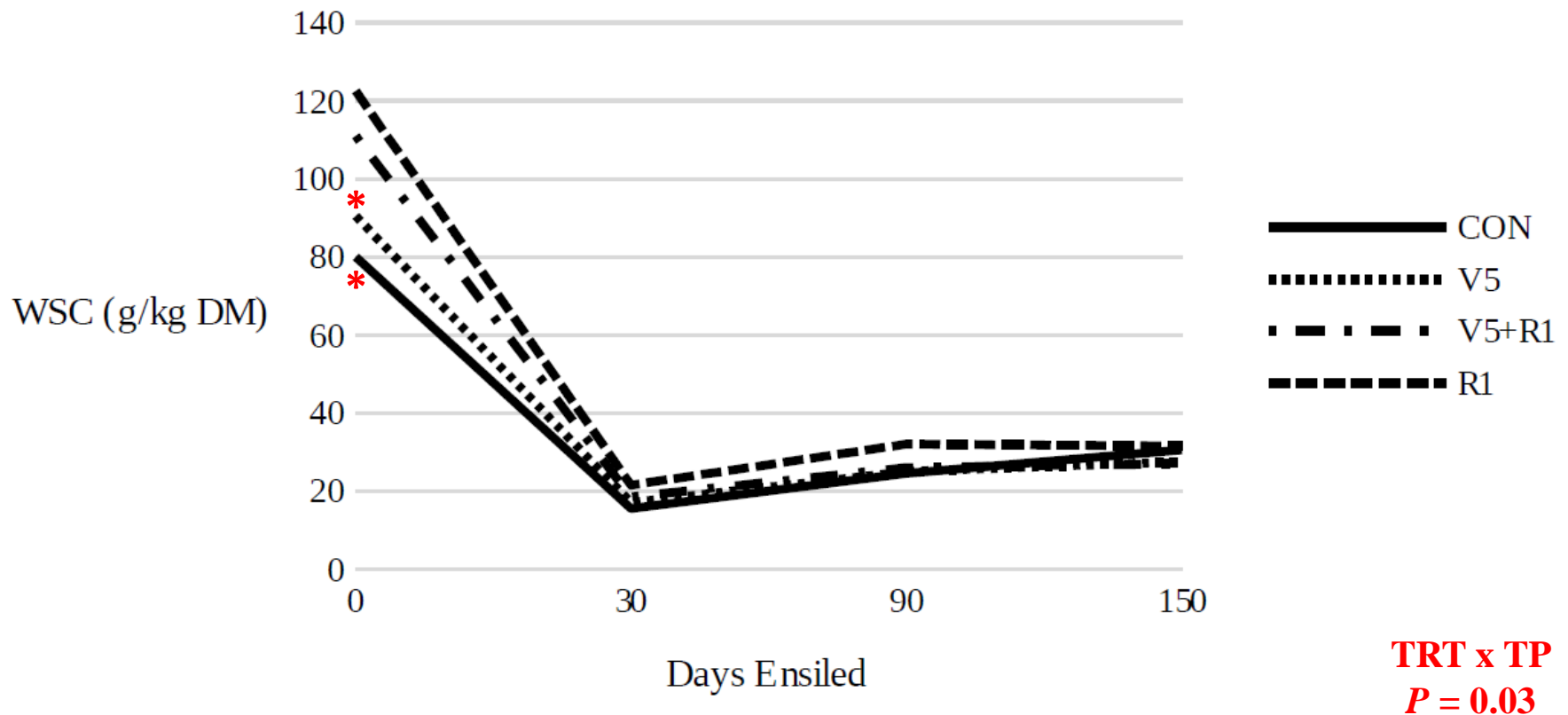
Material and Methods

Harvest:

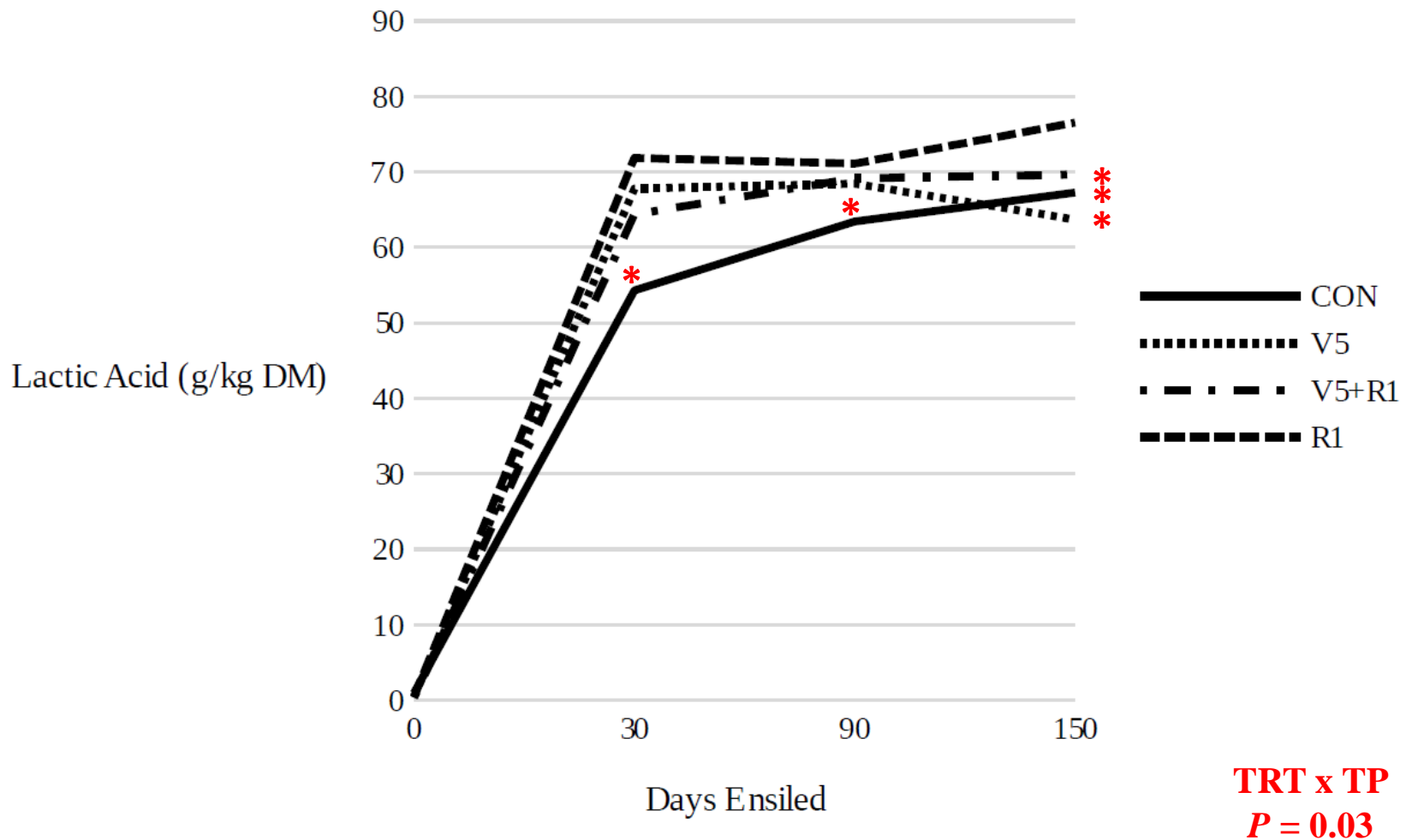
- August 25, 2015 for CON, V5, V5+R1, R1
 - 26.5%, 34.4%, 27.7% and 33.2%, respectively
- 1.9 cm theoretical length of chop
- Kernel Processor



Water soluble carbohydrates (WSC) in corn silage



Lactic acid in corn silage

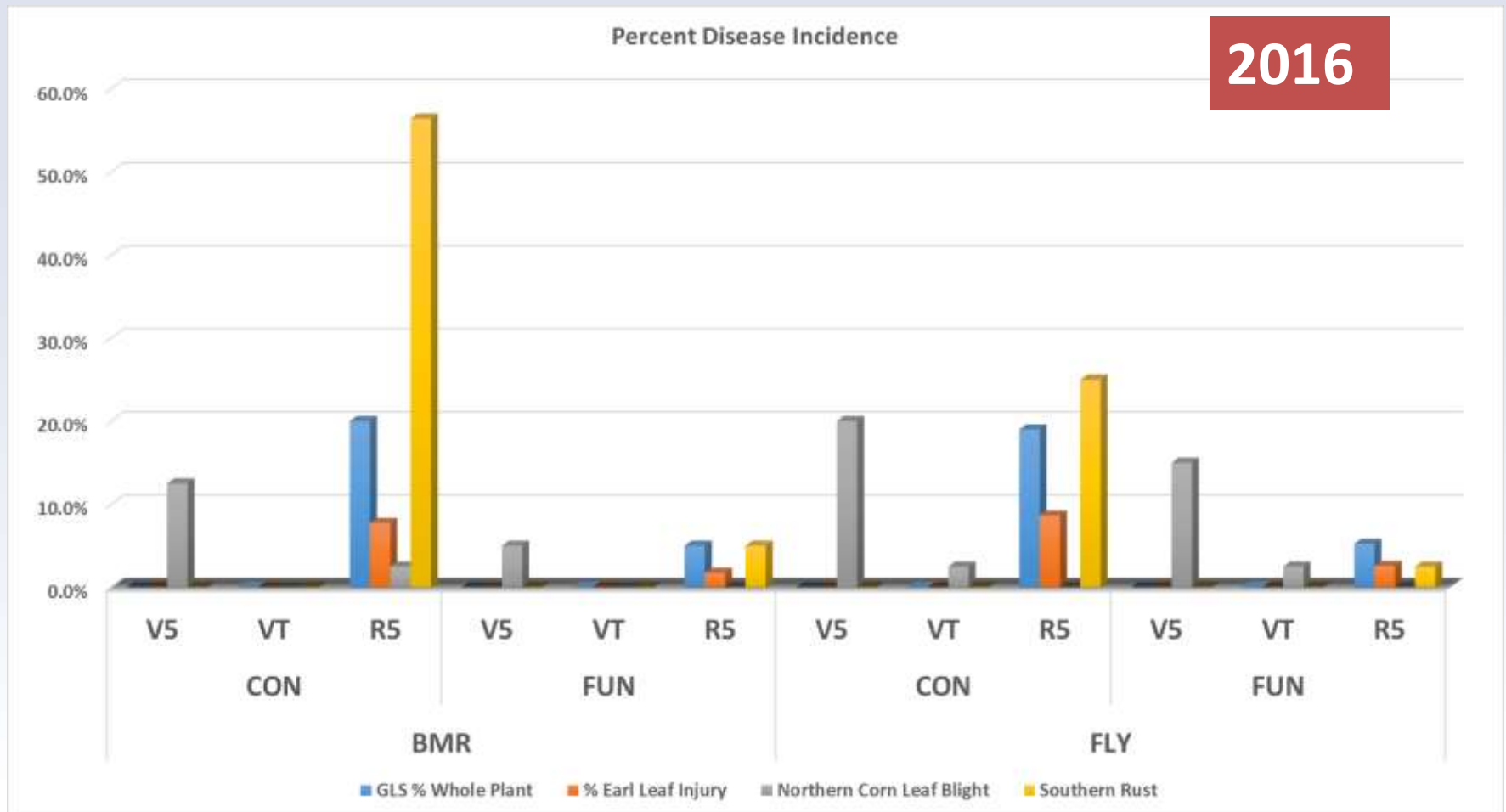


Corn Silage Conclusions

- Applications of fungicide on corn resulted in
 - Greatest water soluble carbohydrate (WSC) content
 - Greatest lactic acid content
- Implication:
 - Applications at V5 or R1 may reduce the fibrous content of corn silage, increase the fermentation products during ensiling, and yield greater milk when fed to dairy cattle



Fungus in Corn

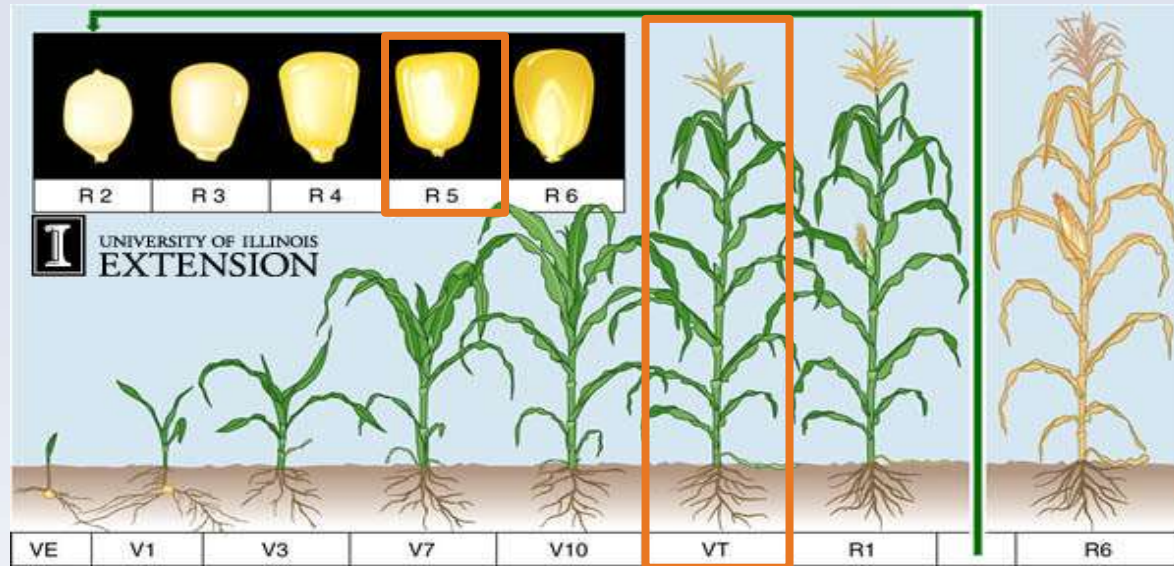


Corn Varieties

- Many different varieties and hybrids to choose from ...
- 1) Flourey (**FLY**):
 - Great DM yield
 - Very low in prolamin proteins (starch-encapsulating storage proteins) → the starch is highly available in the rumen
 - Higher lignin content → greater structural components = able to withstand wind/weather in field
 - Lower whole plant fiber digestibility
(Sniffen, 2016, Mahanna, 2009)
- 2) Brown mid-rib (**BMR**):
 - Lower lignin
 - Greater whole plant fiber digestibility
 - Lower DM yield
 - Less ability to withstand wind in field
(Block et al., 1981; Oba and Allen, 1999; Dominguez et al., 2002)



Treatments



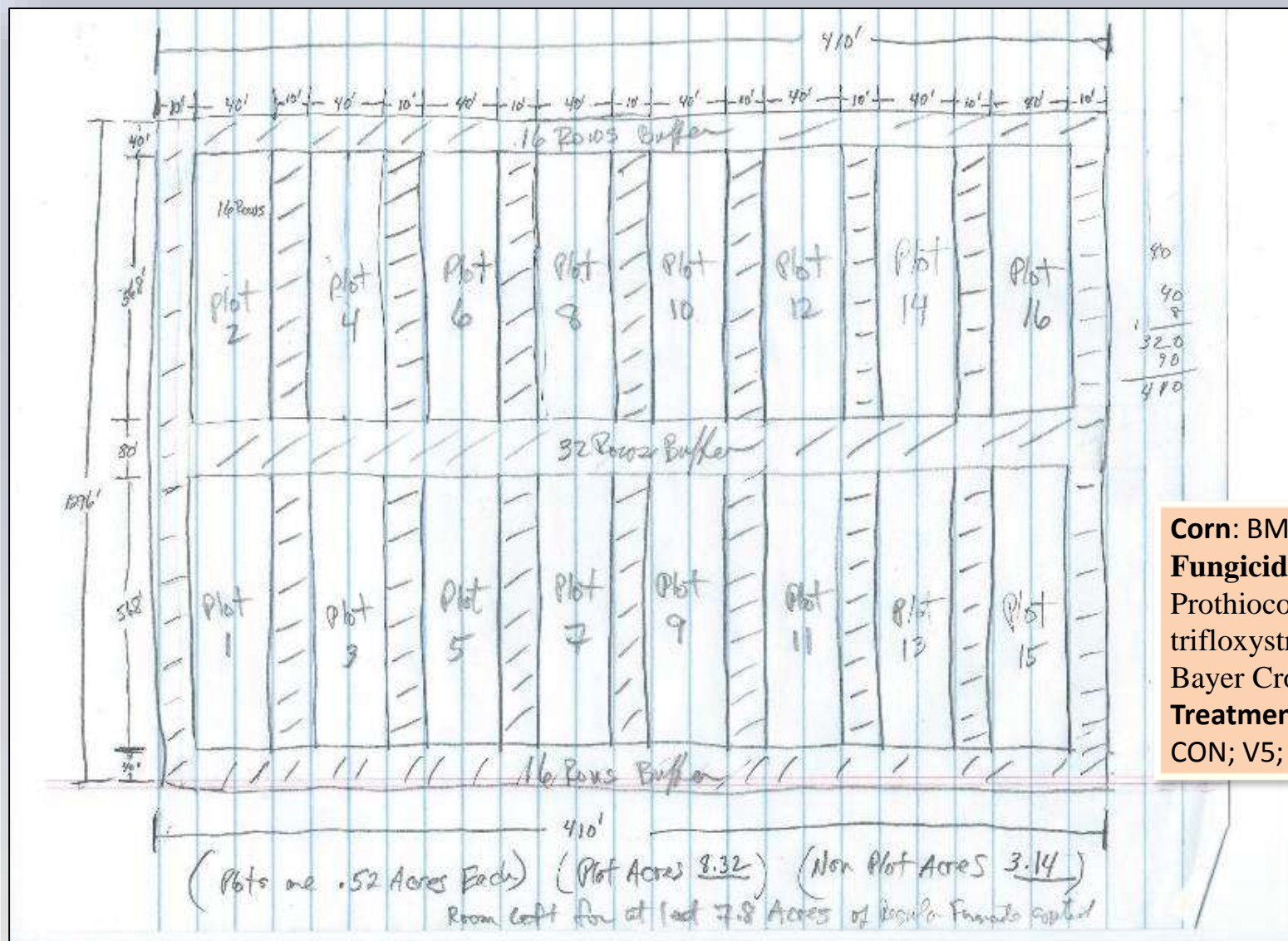
Headline[®] AMP: Pyraclostrobin (13.64%) + Metconazole (5.14%)



Results: Yield

	Treatments				P-Value			
	BMR		FLY		SEM	Variety	Treatment	Variety× Treatment
	CON	FUN	CON	FUN				
Gross silage yield per acre, tons	28.6	30.3	27.9	30.2	0.8	0.57	0.08	0.66
DM, %	31.2	26.7	29.5	28.1	0.01	0.84	<0.0001	0.006
DM silage yield per acre, tons	9.0	8.1	8.4	8.4	0.3	0.57	0.10	0.02
Kernel Processing Score, %	76.0	72.5	68.0	72.8	0.03	0.35	0.79	0.12





2017

Corn: BMR (P1180XR).

Fungicide:

Prothioconazole and
trifloxystrobin (Delaro,
Bayer CropScience).

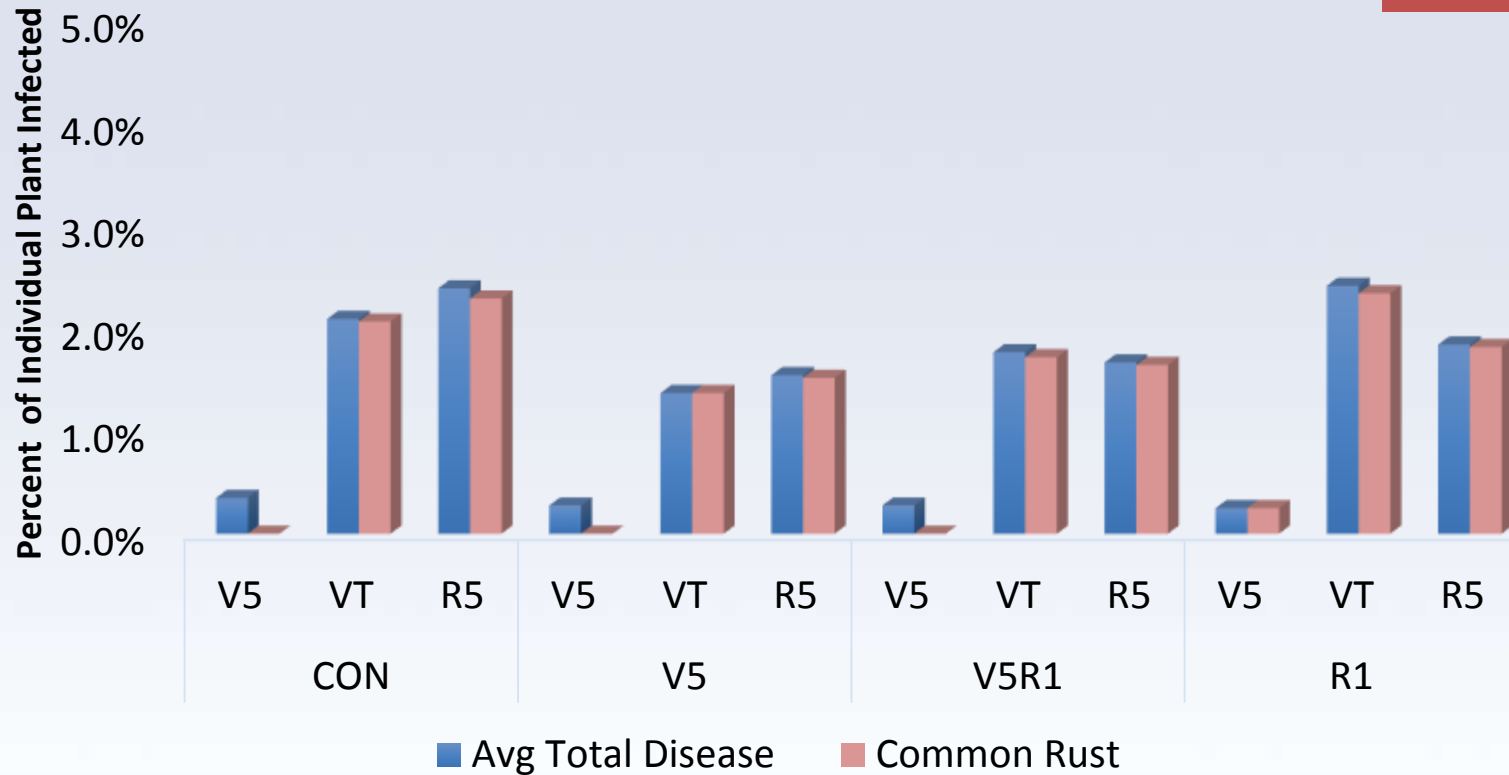
Treatments:

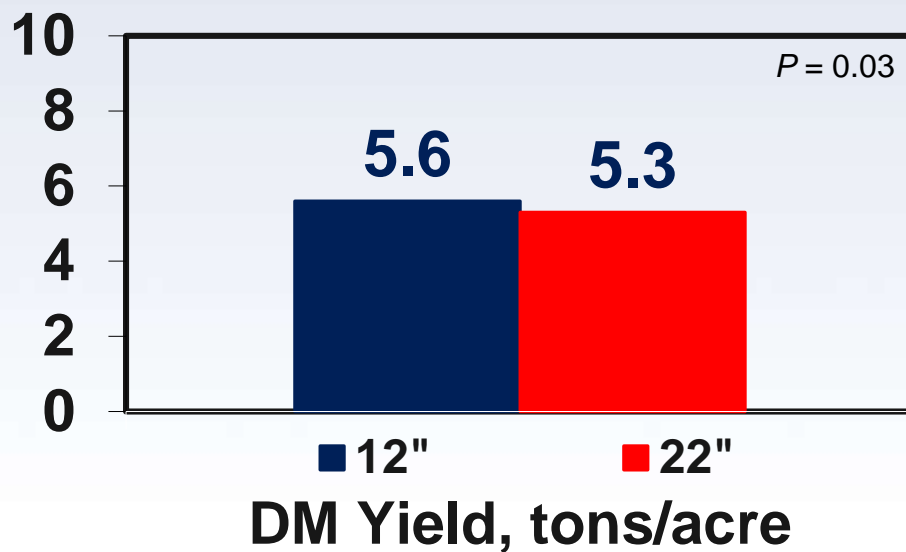
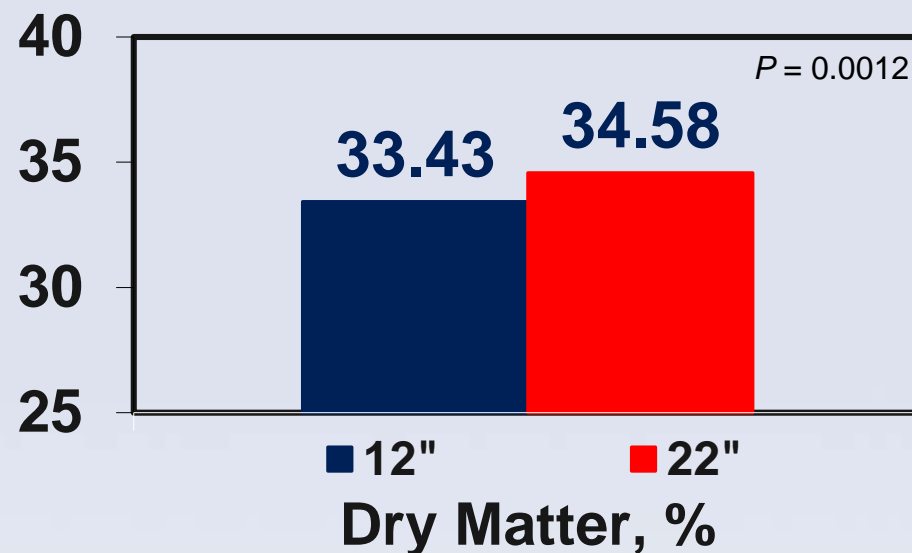
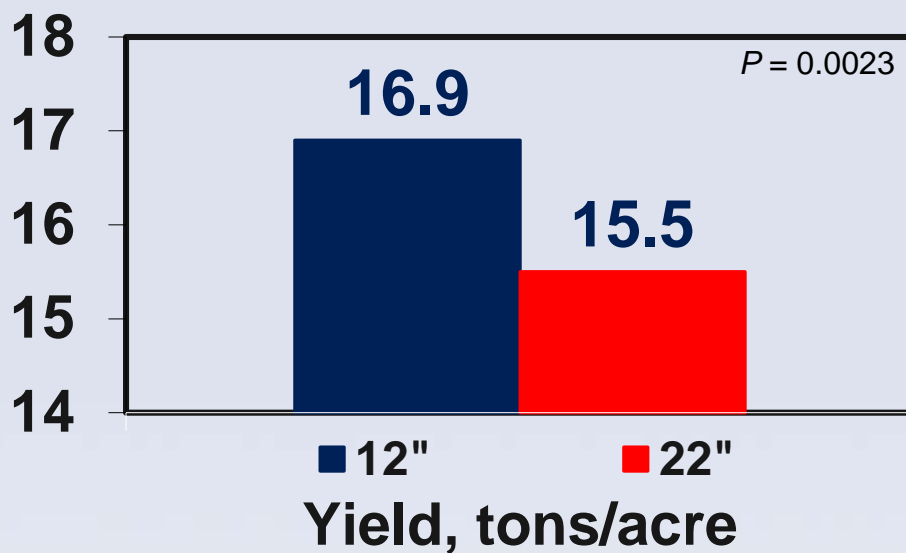
CON; V5; V5R1; R1



Fungus in BMR Corn

2017





Difference

Yield = 1.4 tons/acre (8.3%)

DM Yield = 0.3 tons/acre (5.3%)



Chop height 12"

Part 1. Determining the costs of corn silage standing in the field.

Corn Price	\$/bushel	\$3.48
Silage Yield	wet tons/acre	18.7
Corn Silage Dry Matter	% dry matter	33.4
Corn Silage Yield (dry)	tons DM/acre	6.25
Estimated Grain Yield	bushels/acre	132.0
Corn Grain Harvesting, Drying and Storage Costs	\$/acre	\$100.00
Net Value of Stover Removed	\$/ton of stover DM	\$10.00
Corn Silage Value - Dry	\$/ton of DM	\$62.32
Corn Silage Value - Dry	\$/ton of DM	\$62.32
Corn Silage Value - Wet	\$/wet ton	\$20.83
Value Per Acre to Crop Grower	\$/acre	\$389.69

Part 2. Determining the costs of corn silage at feeding.

Harvest, Hauling and Storage Cost	\$/wet ton	\$10.00
Cost of Silage to Producer (before shrink)	\$/wet ton	\$30.83
Shrink	% of DM	15
Cost of Silage Lost to Shrink	\$/wet ton	\$3.13
Total Cost of Silage to Producer	\$/wet ton	\$33.96

Chop height 22"

Part 1. Determining the costs of corn silage standing in the field.

\$/bushel	\$3.48
wet tons/acre	17.1
% dry matter	34.6
tons DM/acre	5.90
bushels/acre	123.7
\$/acre	\$100.00
\$/ton of stover DM	\$10.00
\$/ton of DM	\$60.88
\$/ton of DM	\$60.88
\$/wet ton	\$21.05
\$/acre	\$359.44

Part 2. Determining the costs of corn silage at feeding.

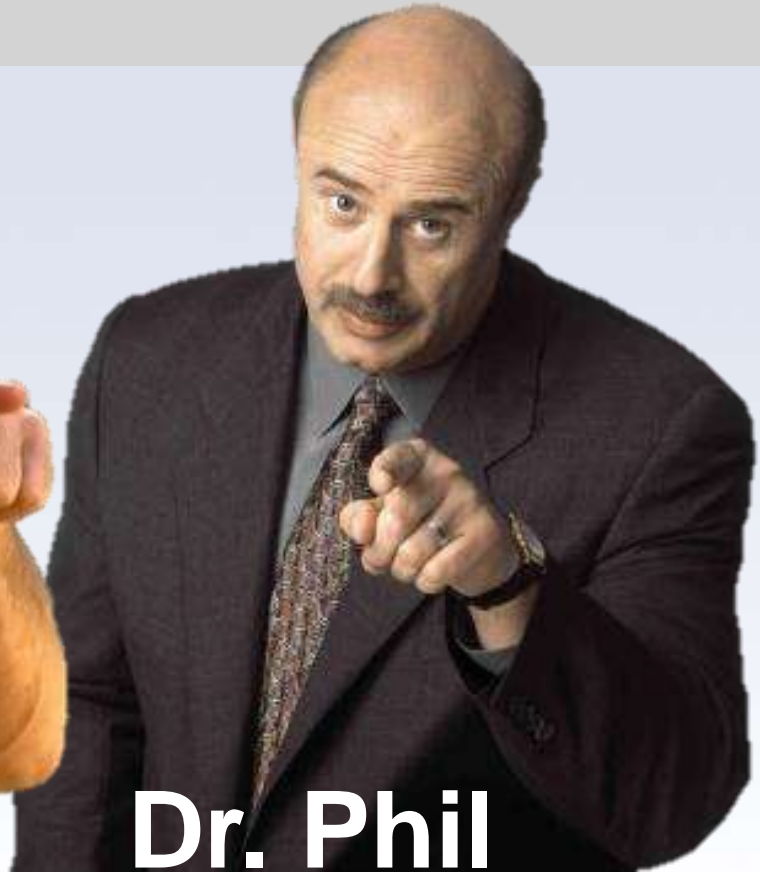
\$/wet ton	\$10.00
\$/wet ton	\$31.05
% of DM	15
\$/wet ton	\$3.16
\$/wet ton	\$34.21



TAKE HOME MESSAGE



Phil



Dr. Phil



Conclusions & Implications

- Corn treated with foliar fungicide had
 - Less fiber, more sugar and fat
 - Better aerobic stability
 - Higher DM digestibility
 - Improved corn plant and corn silage quality
- Cows fed silage receiving foliar fungicide had
 - Lower DMI
 - Higher feed efficiency
 - Higher IOFC



For the road...

- **Scout corn at V5**
 - If diseased (> 5%) apply fungicide at V5 and R1
- **Scout corn at R1 (may be too late ☹)**
 - If diseased (> 5%) apply fungicide at R1
- **ONE Fungicide application at VT/R1, even if corn is not diseased, seems to improve corn silage quality and milk production**

How tall can you go?





THANK YOU!

Phil Cardoso

Department of Animal Sciences

University of Illinois

cardoso2@illinois.edu

www.dairyfocus.illinois.edu



illinois.edu

