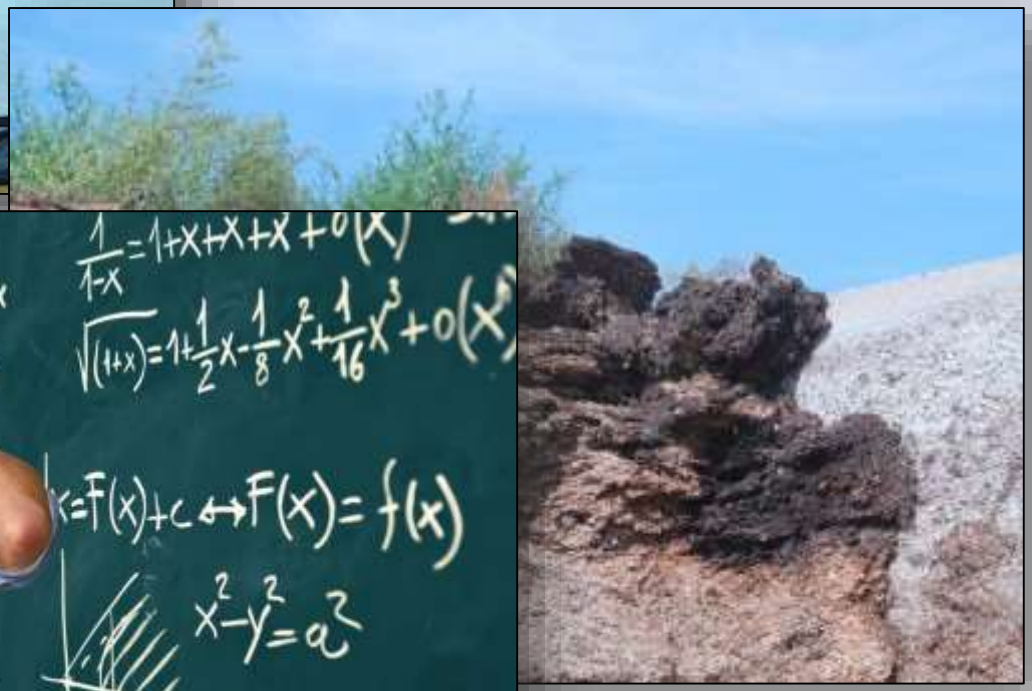
Corn Silage Mycotoxins... and more

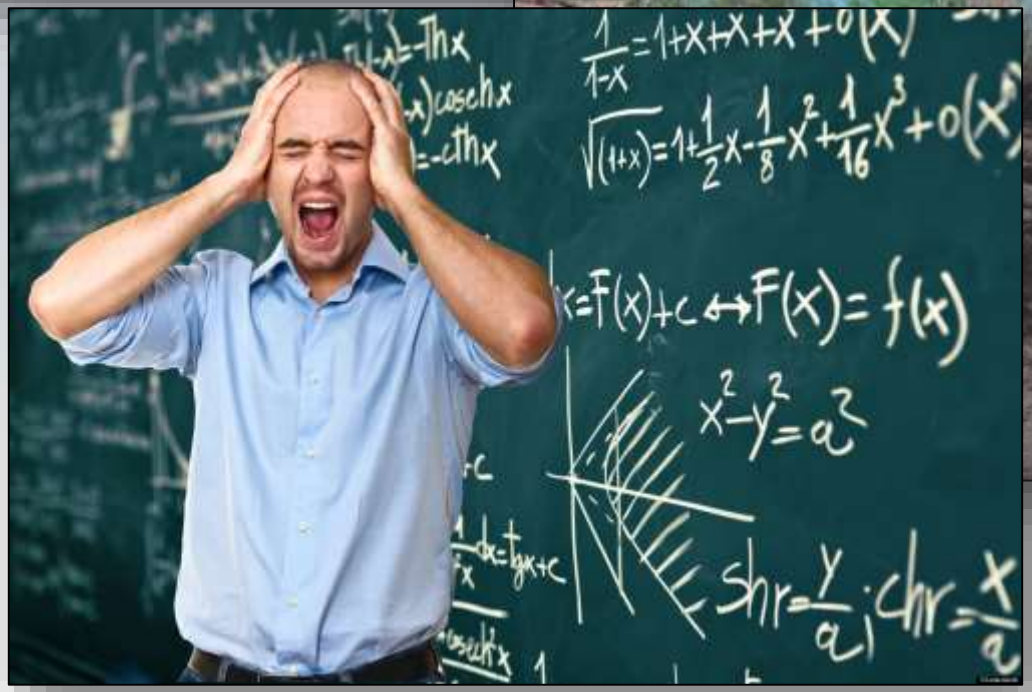
Dairy Forage Seminar

October 5th, 2018

Phil Cardoso, DVM, MS, PhD

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN





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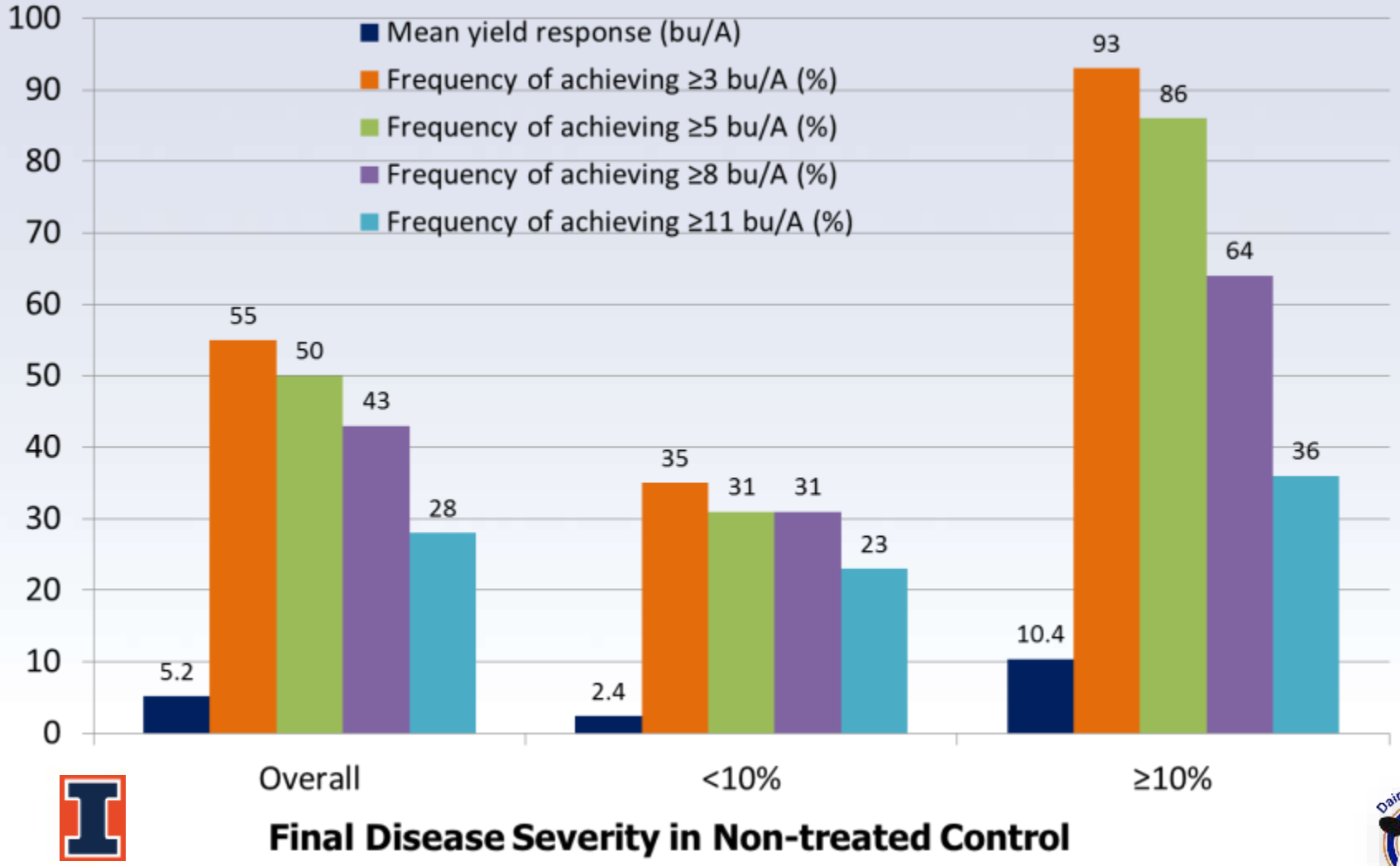
Corn Silage Numbers…

- 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



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Adapted from Carl Bradley

Key Forage Quality Factors

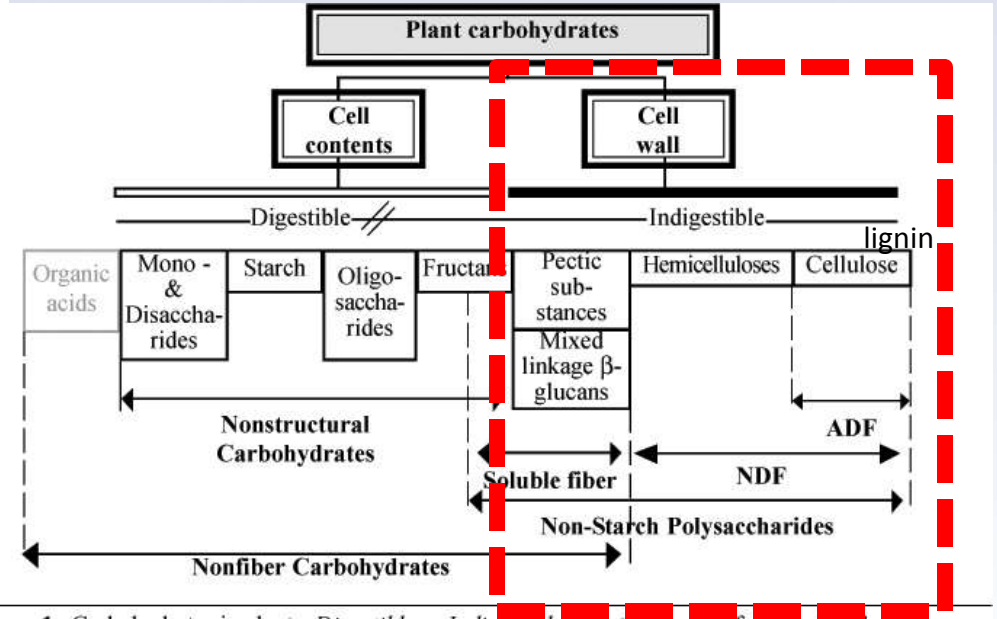
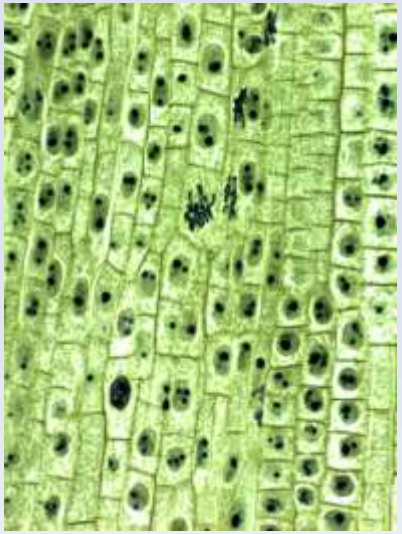


Figure 1 - Carbohydrates in plants. *Digestible or Indigestible* refer to potential for digestion by enzymes in the small intestine; all carbohydrates shown are potentially fermentable. Organic acids are not a carbohydrate, but their mass is included in the nonfiber carbohydrate value that is calculated 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

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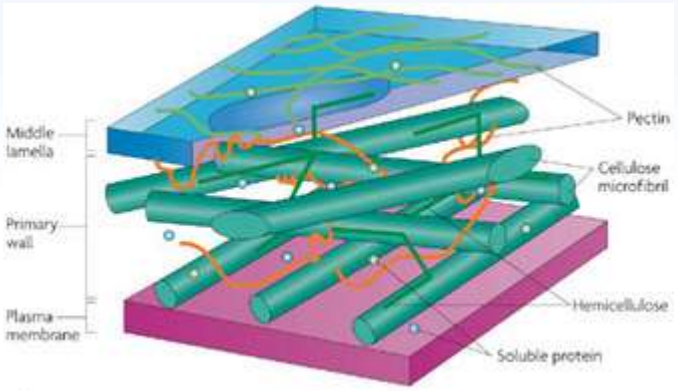
Key Forage Quality Factors

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 (Fumonisins; 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 ± 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

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!

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

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Dairy Focus Lab

J. Dairy Sci. 98:8962–8972
http://dx.doi.org/10.3168/jds.2015-9887

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

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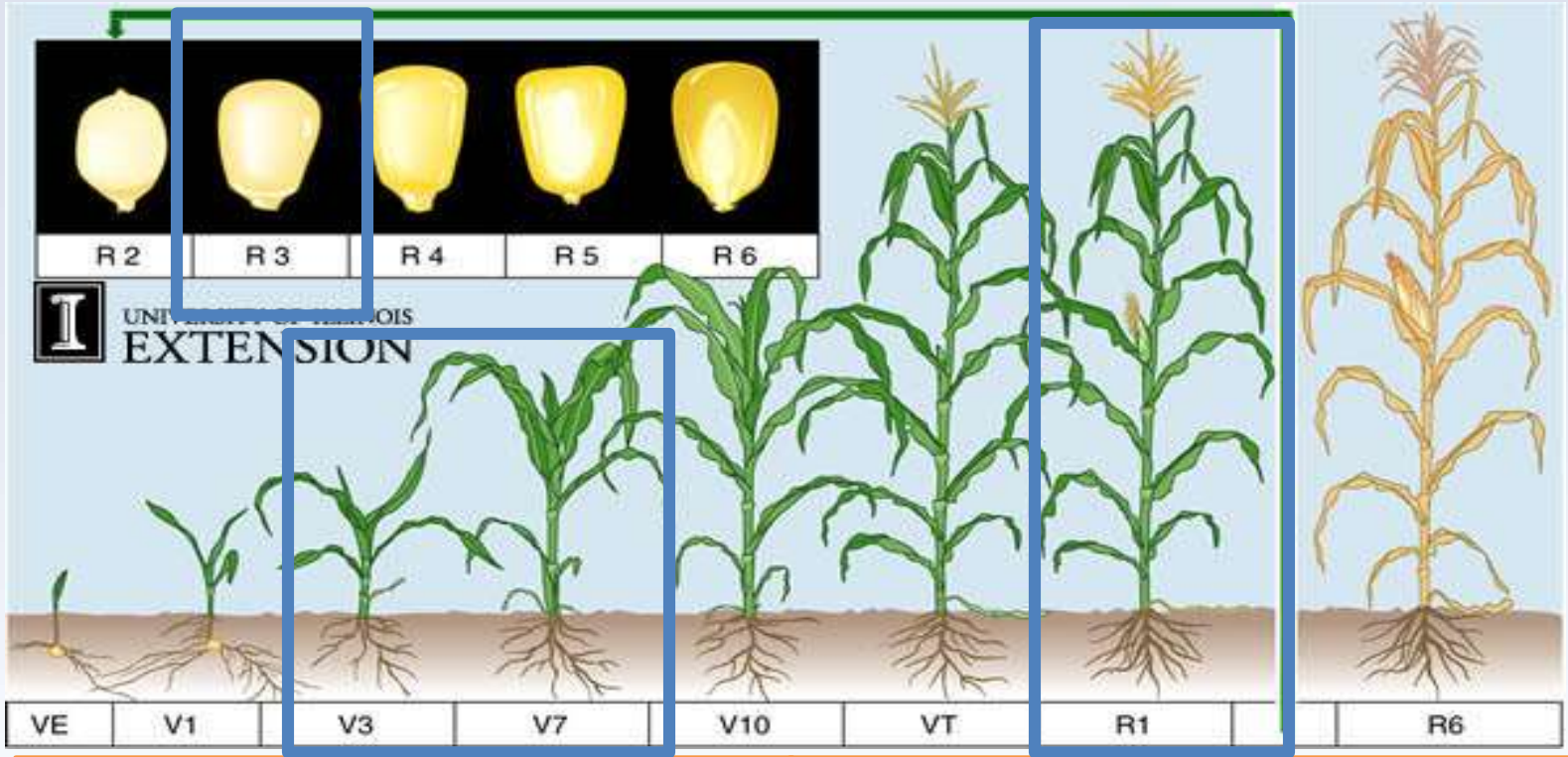
Materials and Methods

- 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

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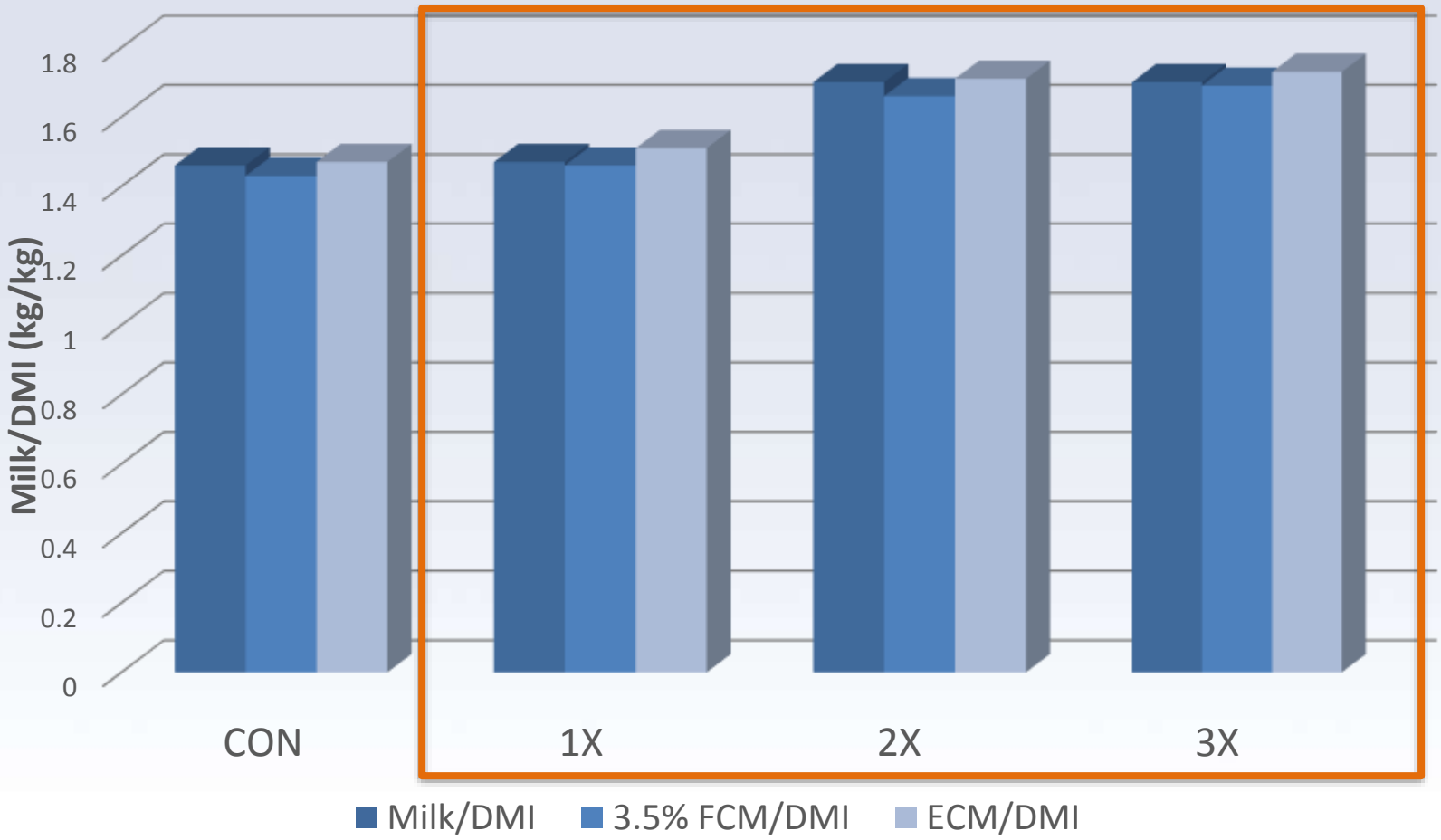
Corn silage yield did not change

- 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

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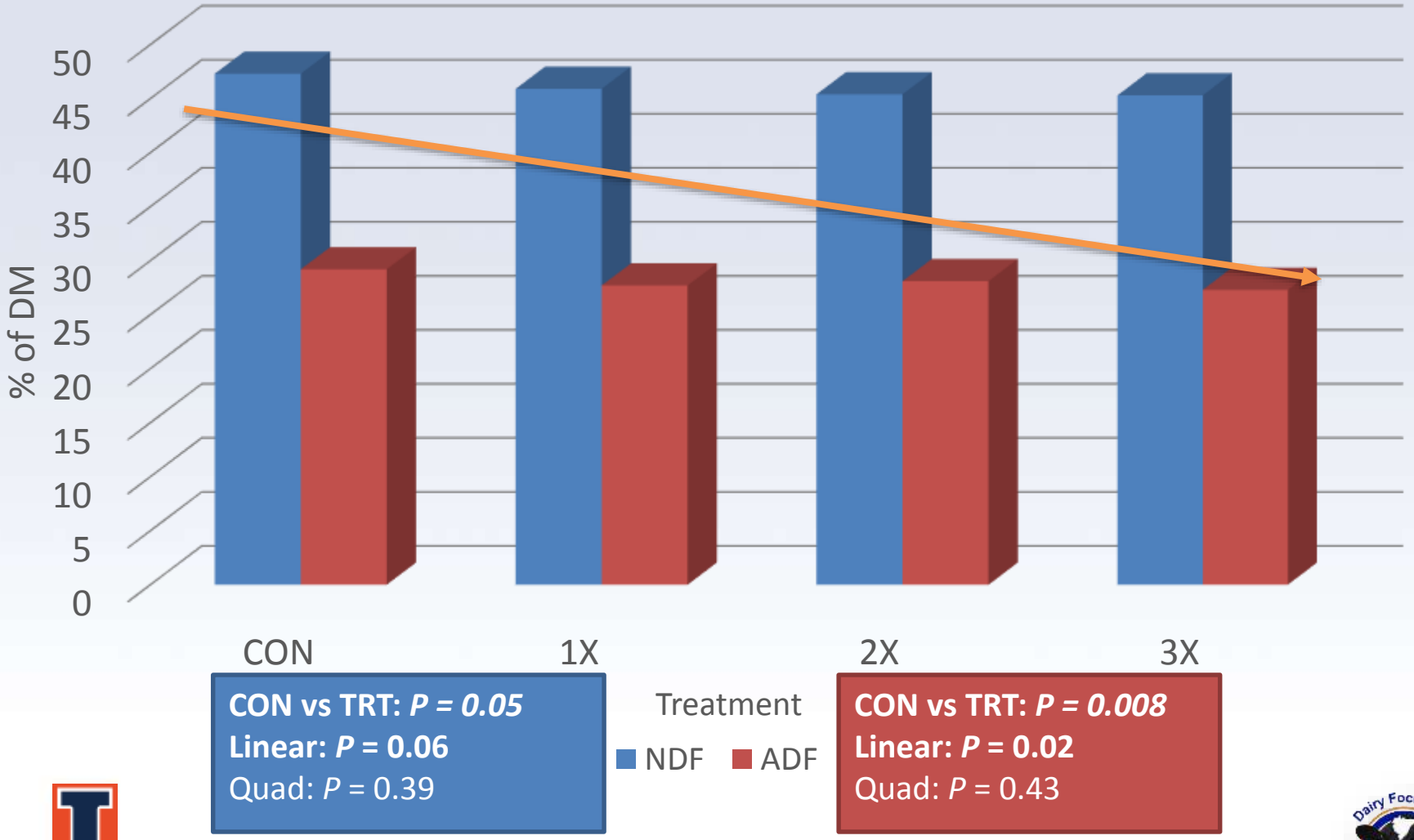
Fiber content decreases as amount of applications increase



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journal homepage: www.elsevier.com/locate/anifeedsci

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,*]

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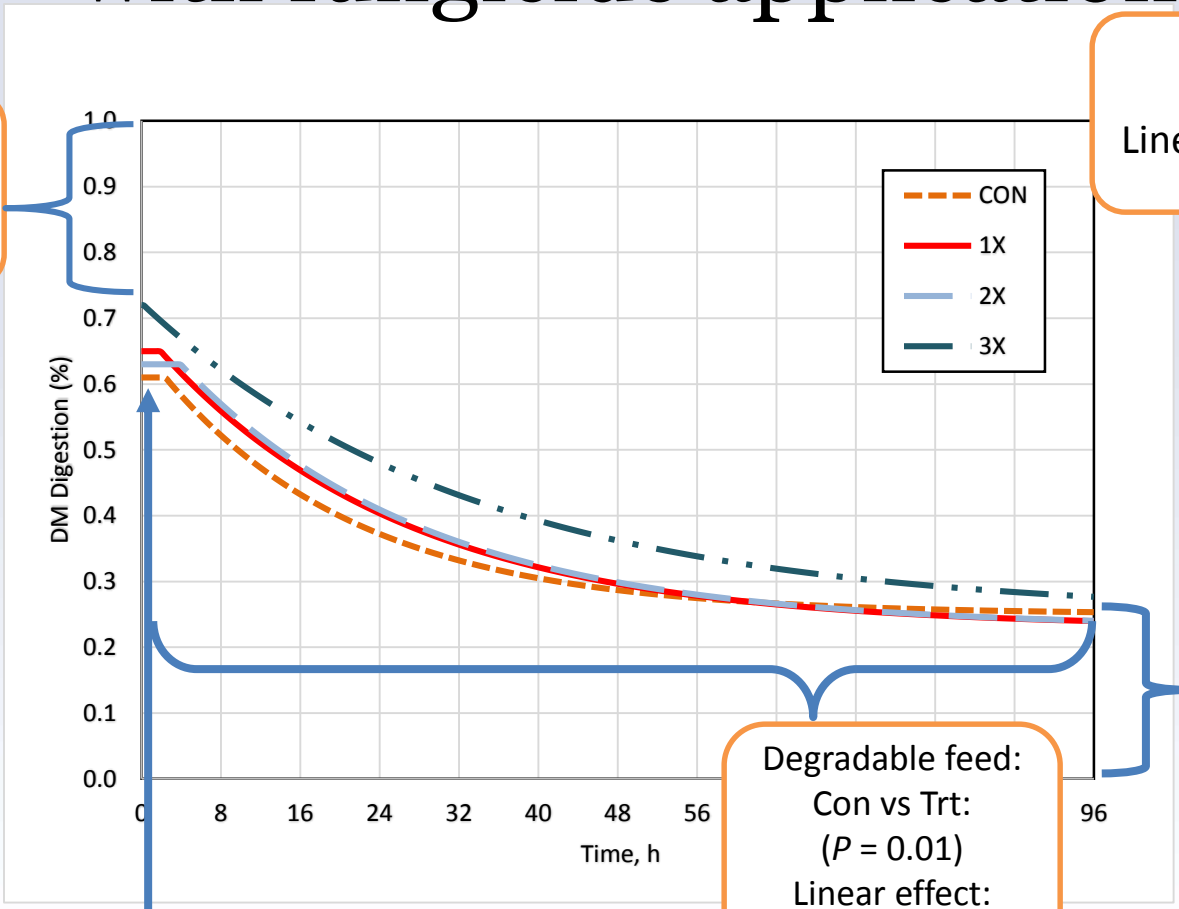
Dry matter degradability is increased with fungicide application

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

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Haerr et al., 2016

Economic Considerations

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

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

CON vs TRT: $ 7.34 vs $7.89

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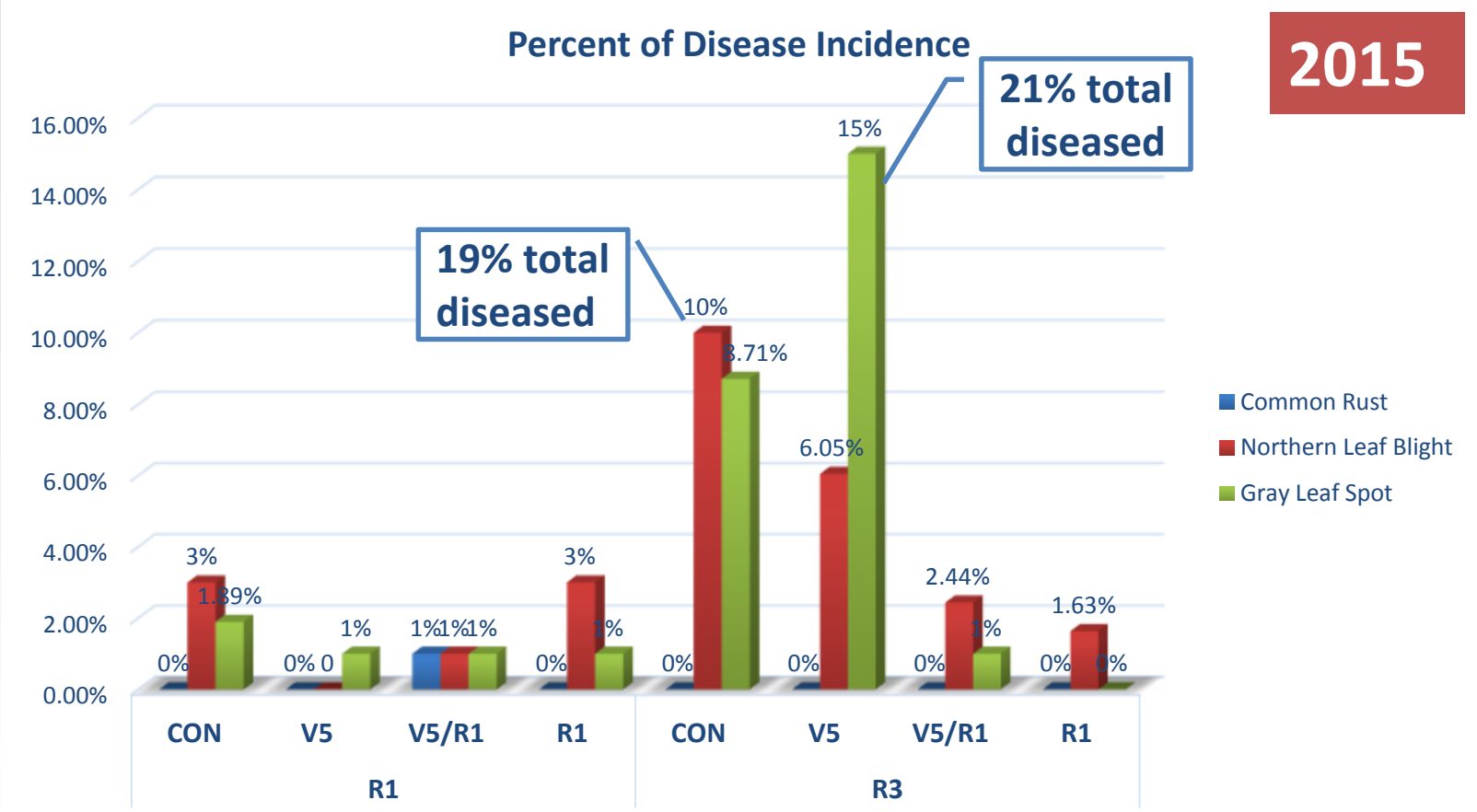
* Income over feed cost calculated as IOFC= milk income - total feed cost

Fungus in Corn



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Kalebich et al., 2017

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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,*]

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

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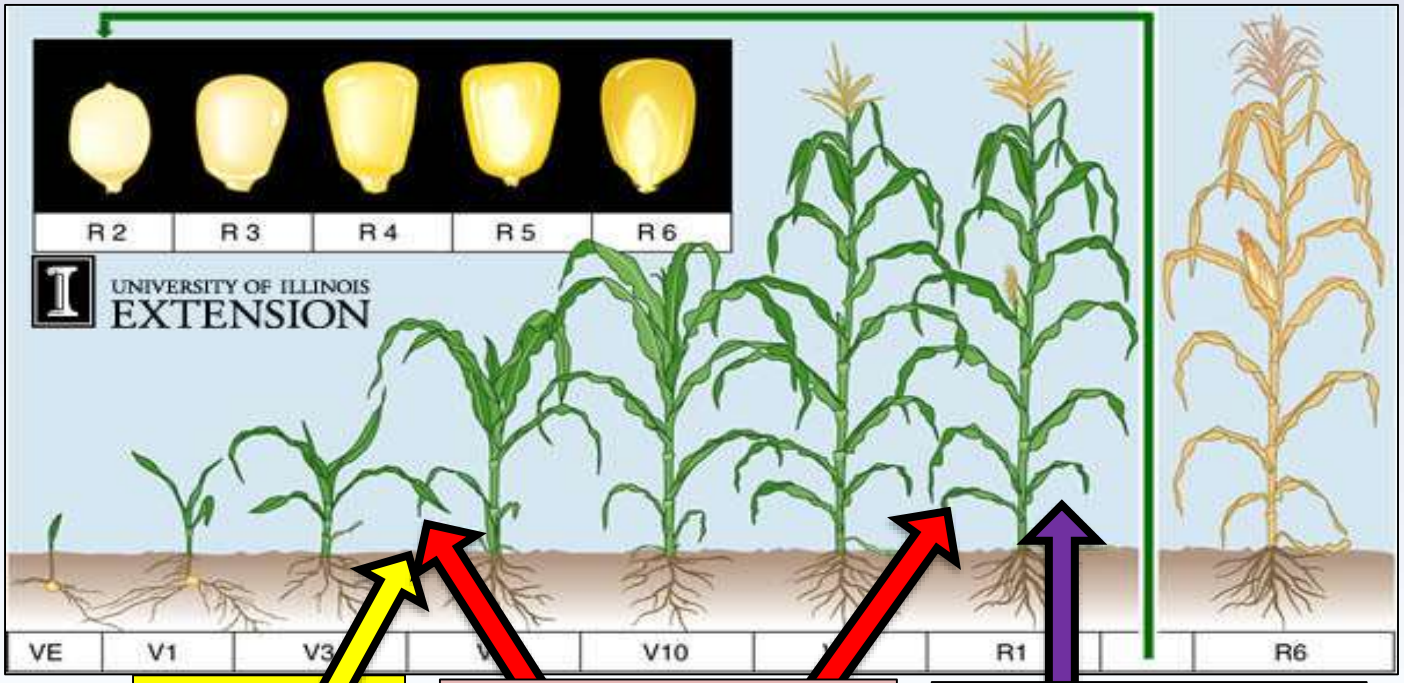
Material and Methods

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 + Metaconzole

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Dairy Focus Lab

Material and Methods

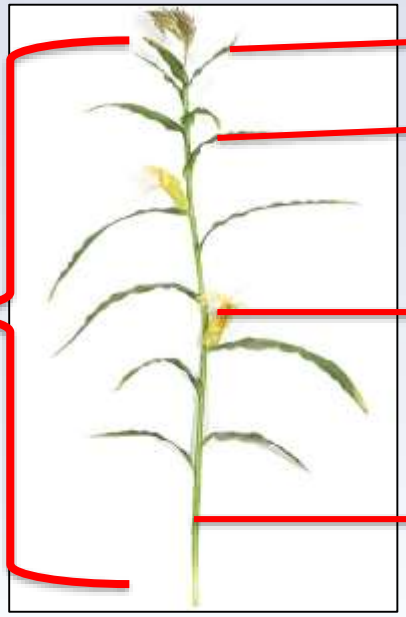
- Corn:
  - Seed: 1417 AMXRR, Pioneer
  - Type: Silage
  - Planted: April 30, 2015 at 32,000 plants/acre
  - Disease Evaluation:
    - July 11, 2015 – R1
    - August 13, 2015 – R3
  - Removed stalks from field at R1 and R3
    - July 12, 2015 – R1
    - August 18, 2015 – R3

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

- Composited

2. Leaves

- Composited

3. Ears = cobs + kernels

- Weight of ears
- Composited

4. Stalks

- Composited

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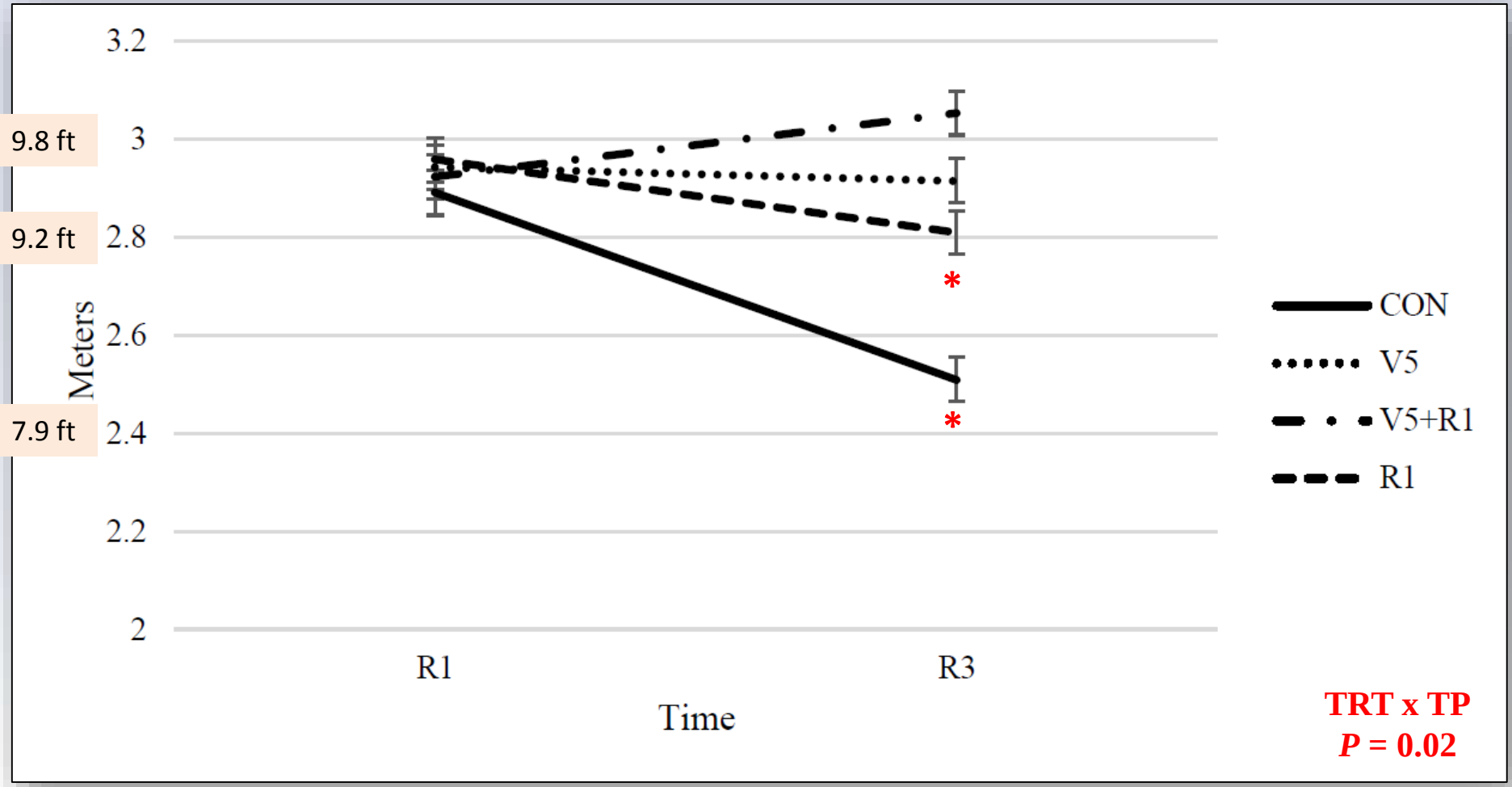
Kalebich et al., 2017

Dairy Focus Lab

Height of corn stalk



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Kalebich et al., 2017

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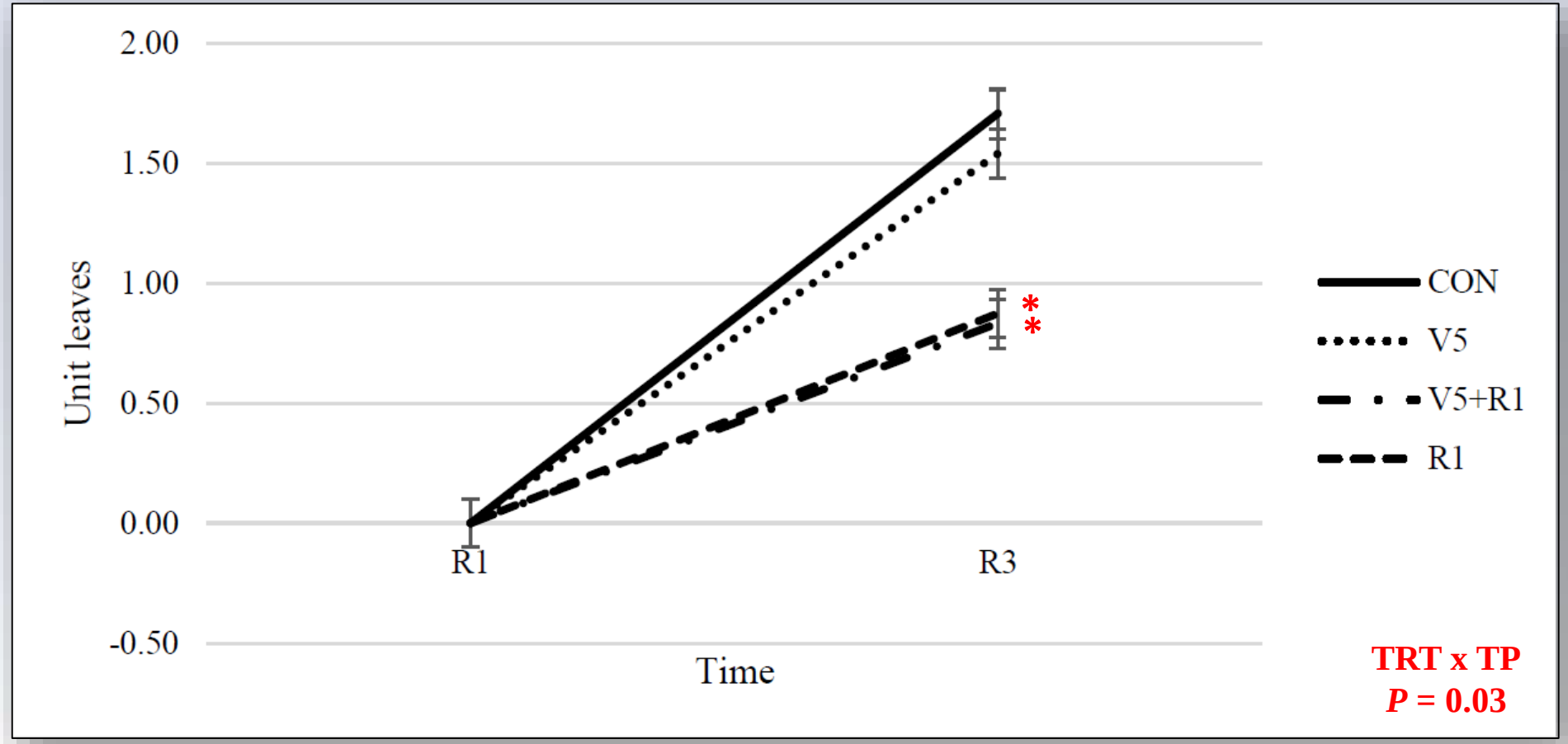
Number of yellow leaves



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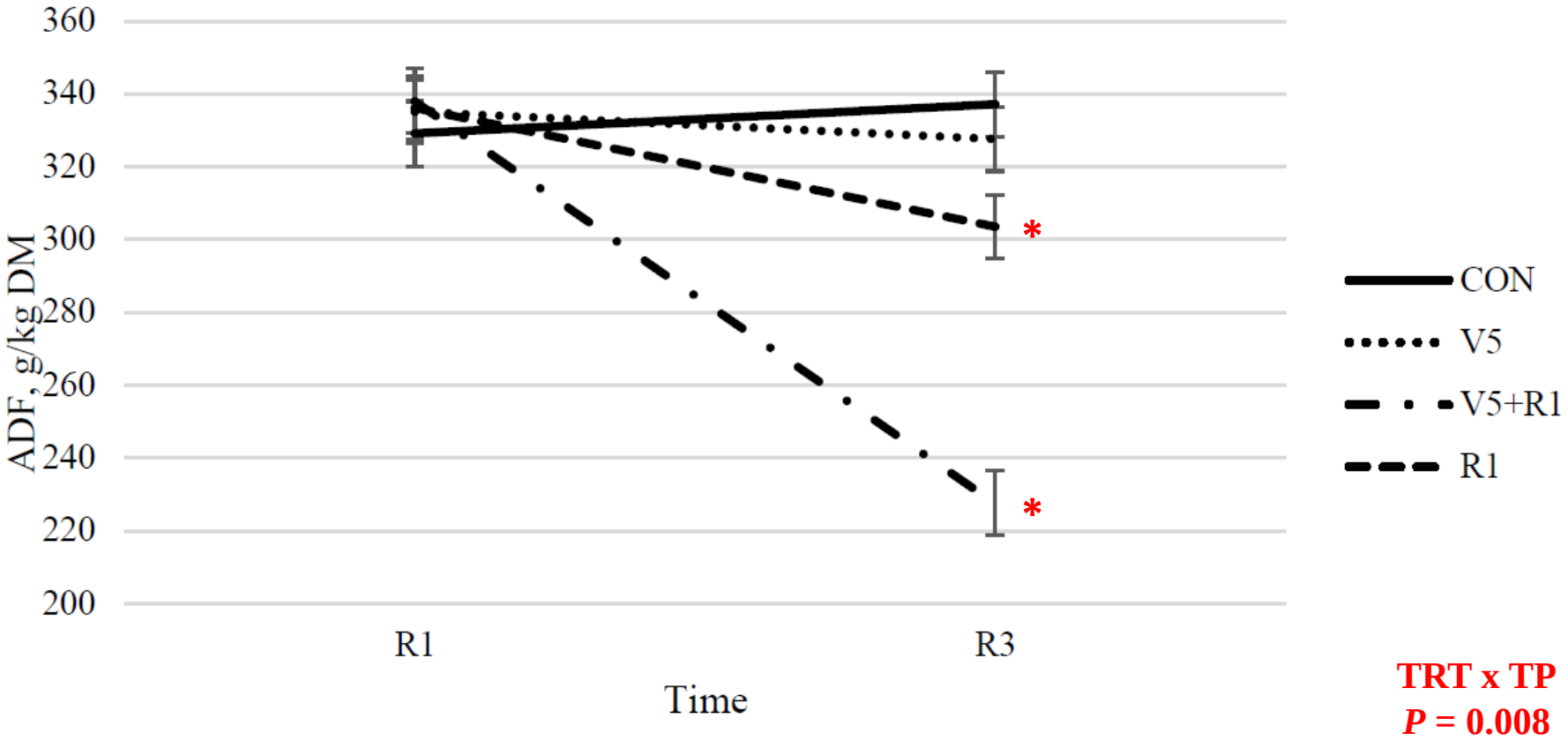
Leaves fiber content



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Kalebich et al., 2017

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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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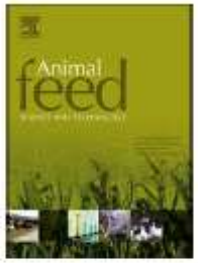

Foliar fungicide (pyraclostrobin) application on corn and its effects on corn silage composition

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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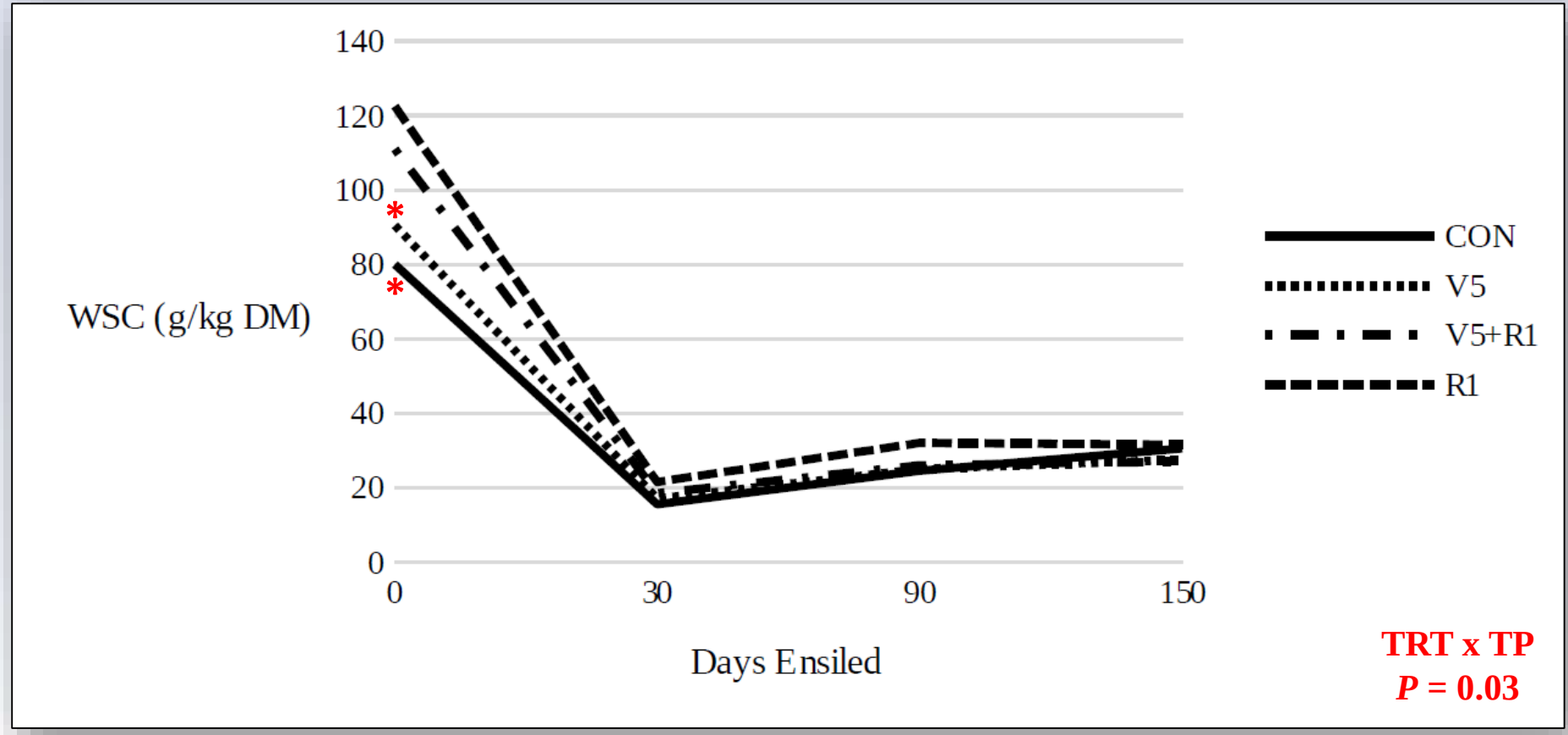
Material and Methods

Harvest:

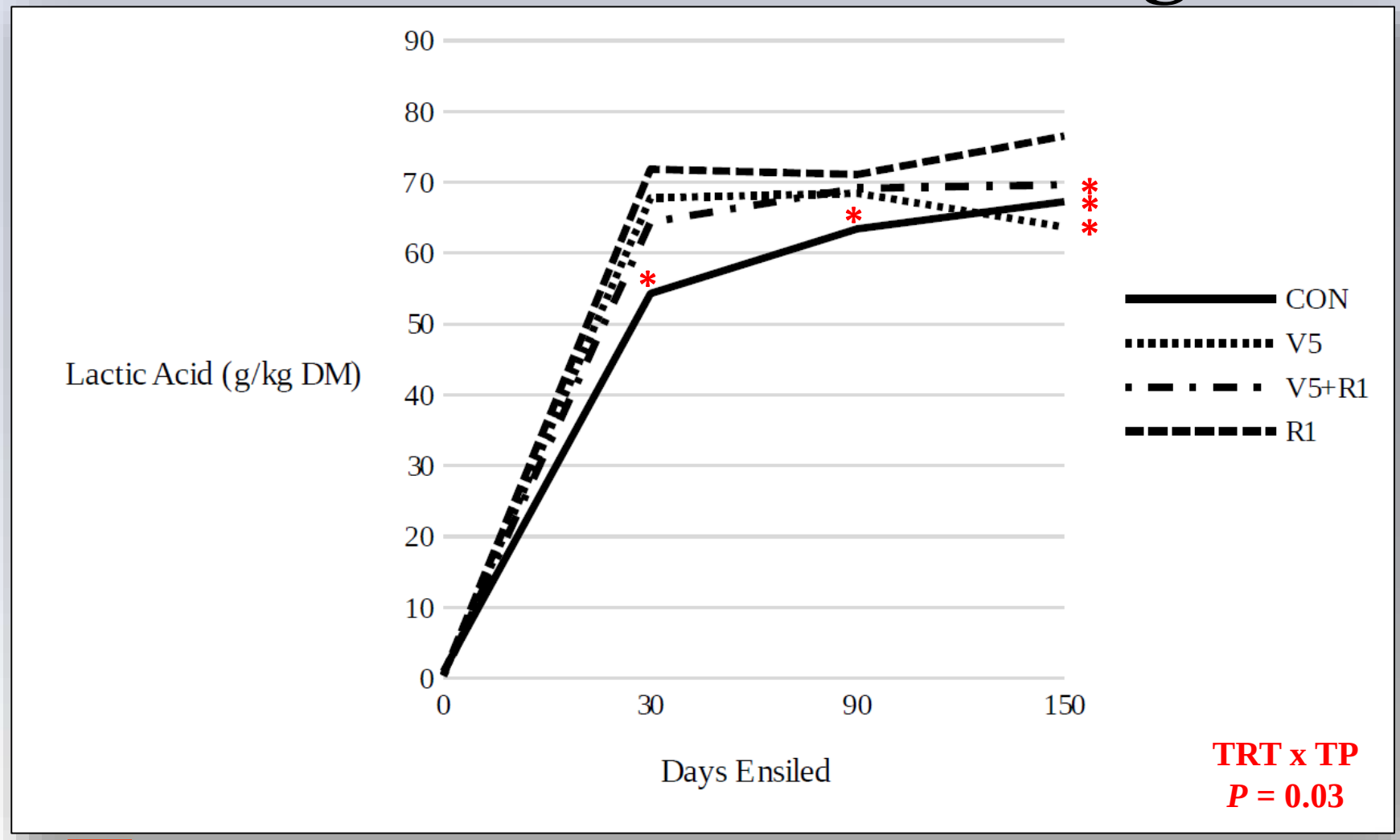
- August 25, 2015 for CON, V5, V5+R1, R1
  - 26.5%, 34.4%, 27.7% and 33.2%, respectively
- 1.9 cm theoretical length of chop
- Kernel Processor

Water soluble carbohydrates (WSC) in corn silage



Kalebich et al., 2017

Lactic acid in corn silage



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Kalebich et al., 2017

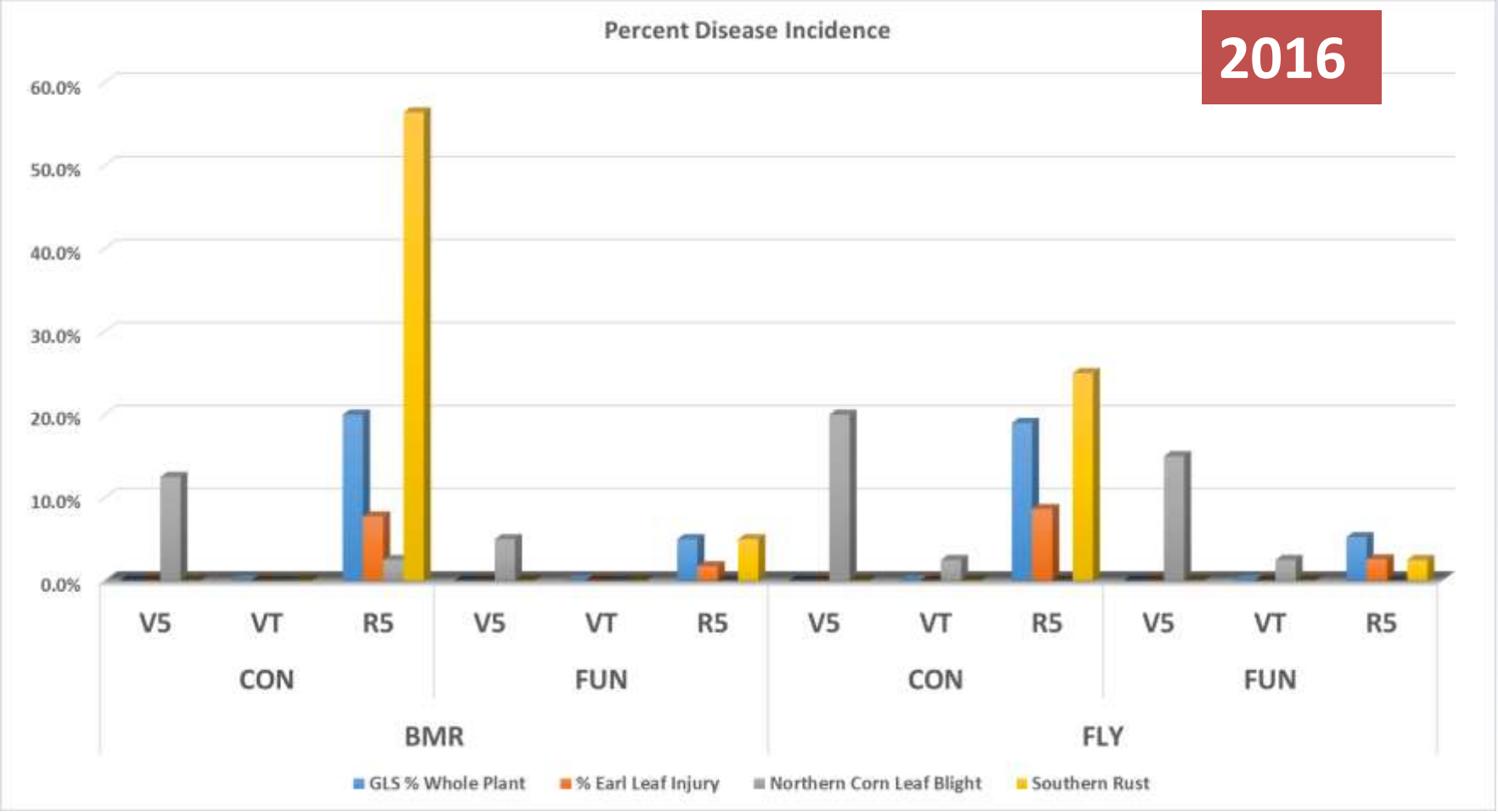
Corn Silage Conclusions

- 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

Kalebich et al., 2017

Fungus in Corn



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Weatherly et al., *unpublished*

Corn Varieties

- Many different varieties and hybrids to choose from …

- 1) Floury (**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

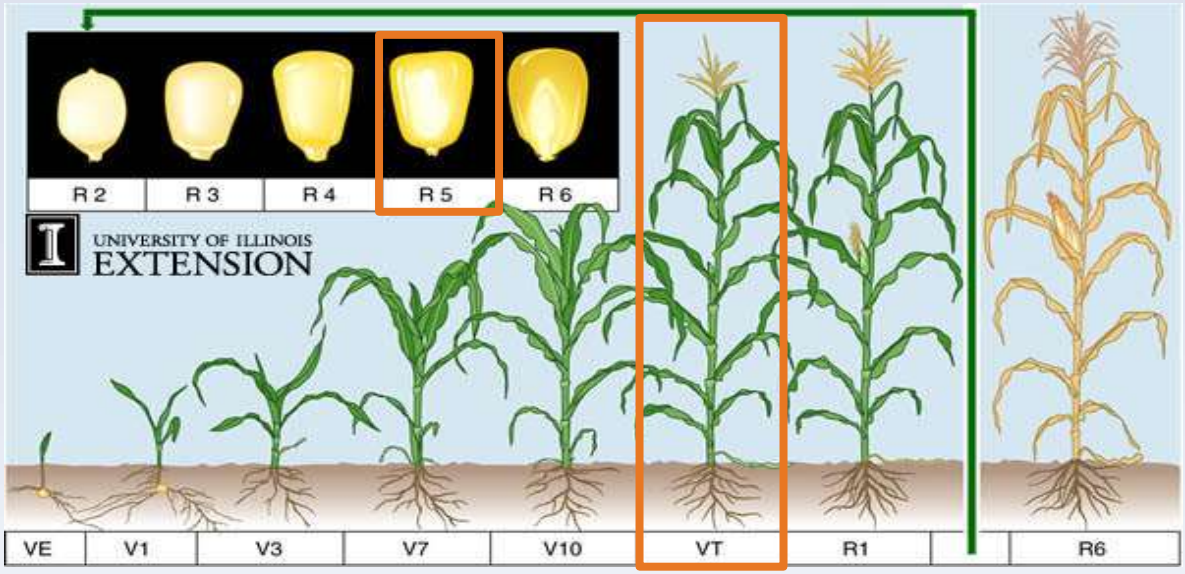
    (Sniffen, 2016, Mahanna, 2009)

- 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)

Weatherly et al., *unpublished*

Treatments



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

Weatherly et al., *unpublished*

Results: Yield

	Treatments					*P*-Value		
	BMR		FLY					
	CON	FUN	CON	FUN	SEM	Variety	Treatment	Variety× Treatment
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

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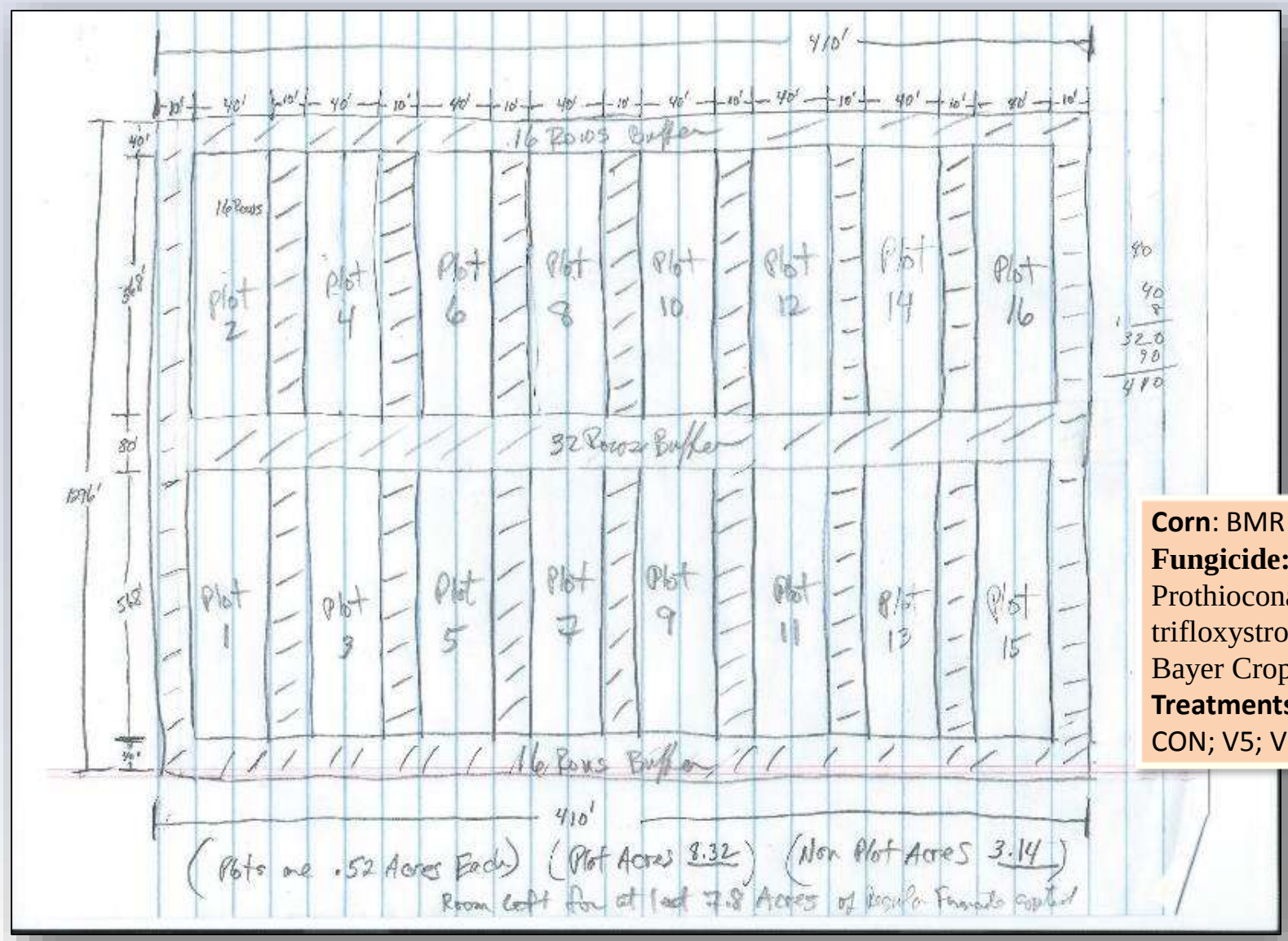
Weatherly et al., *unpublished*



2017

Corn: BMR (P1180XR).
Fungicide:
Prothioconazole and trifloxystrobin (Delaro, Bayer CropScience).
Treatments:
CON; V5; V5R1; R1

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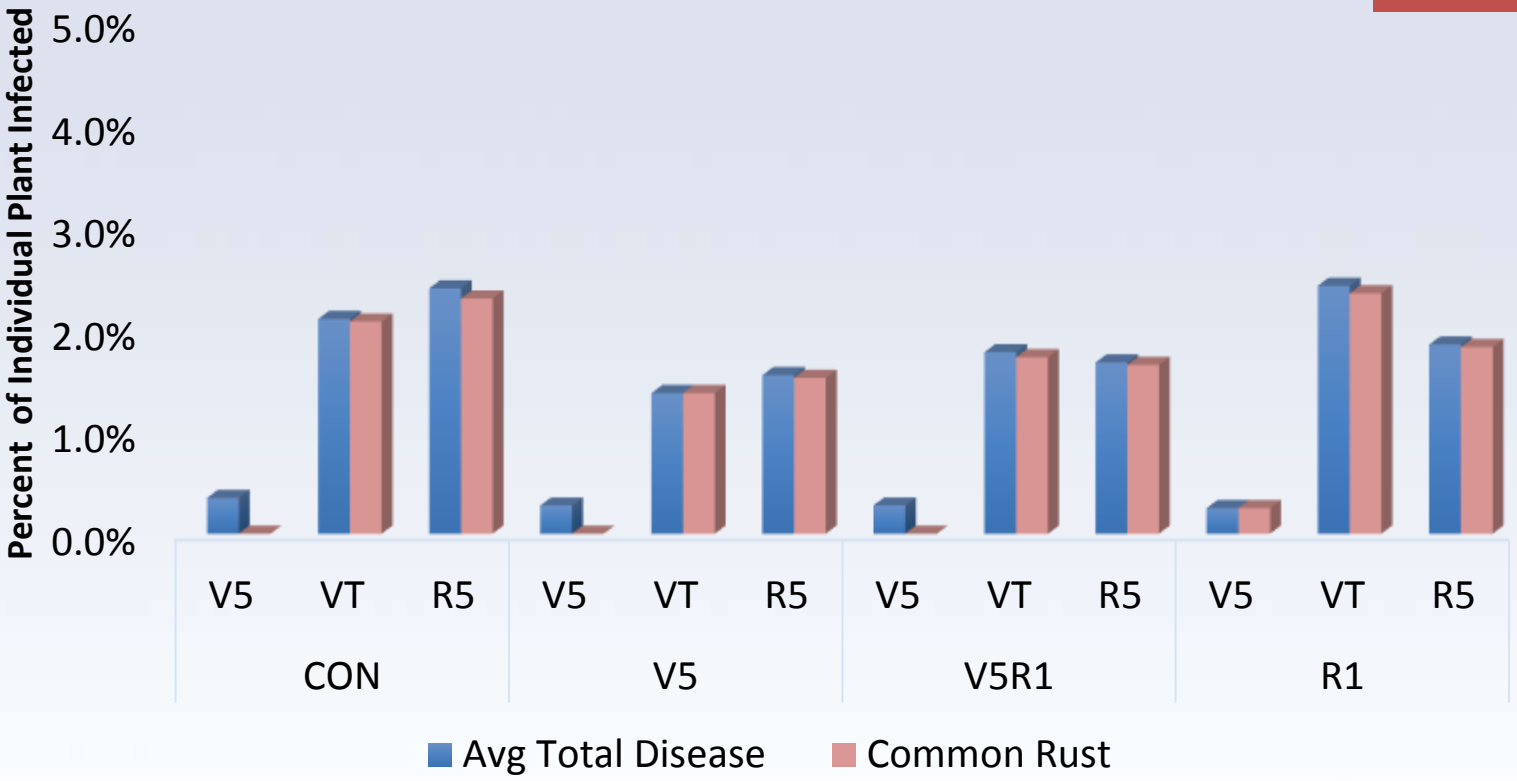
Damery et al., *unpublished*

Fungus in BMR Corn

2017



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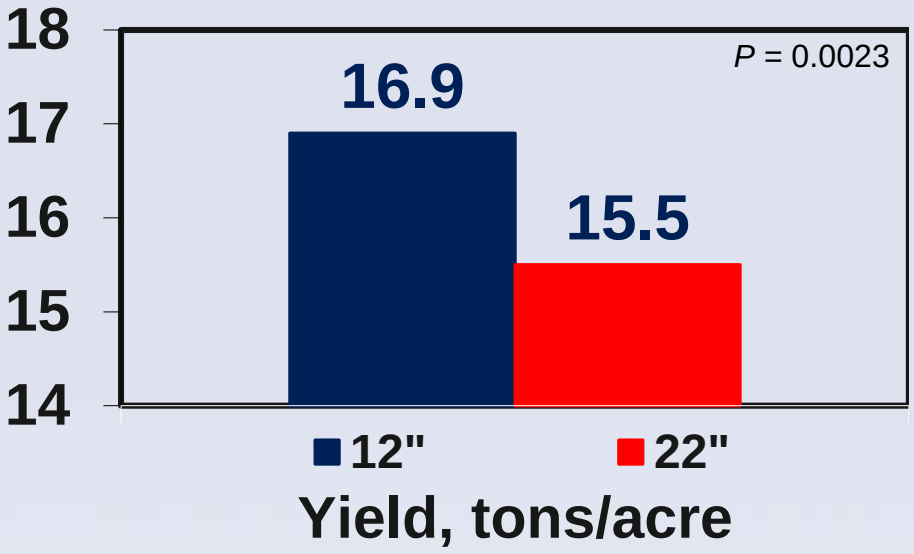
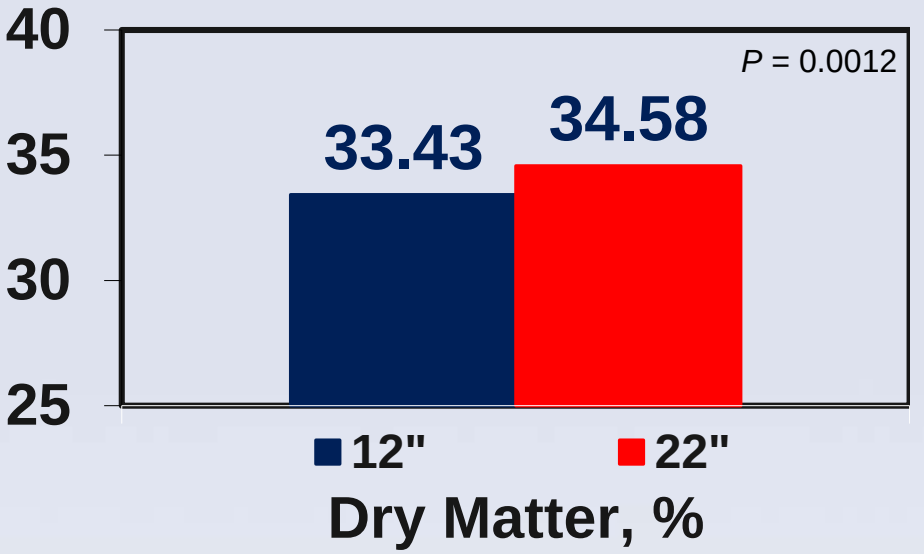
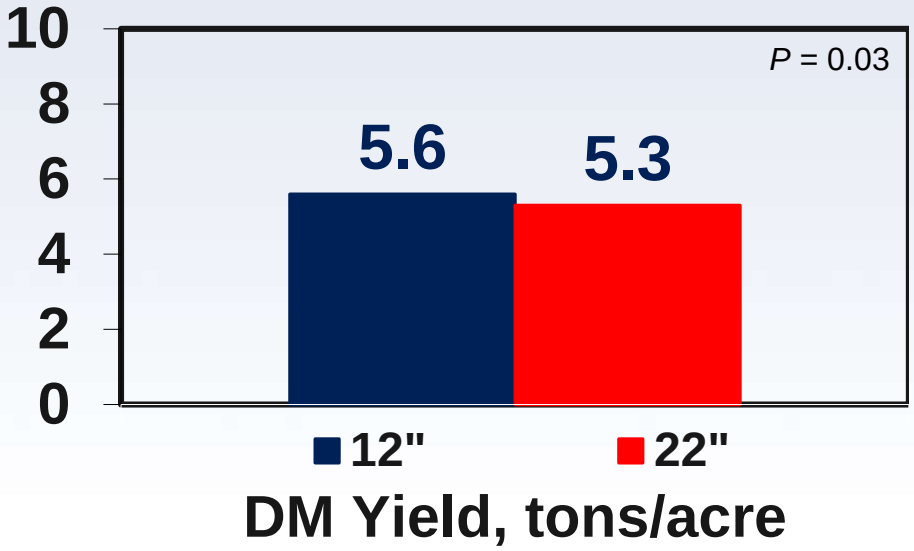
Damery et al., *unpublished*







Difference

Yield = 1.4 tons/acre (8.3%)

DM Yield = 0.3 tons/acre (5.3%)

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Damery et al., *unpublished*

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**

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https://www.extension.purdue.edu/extmedia/AS/AS-611-W.pdf

Damery et al., *unpublished*

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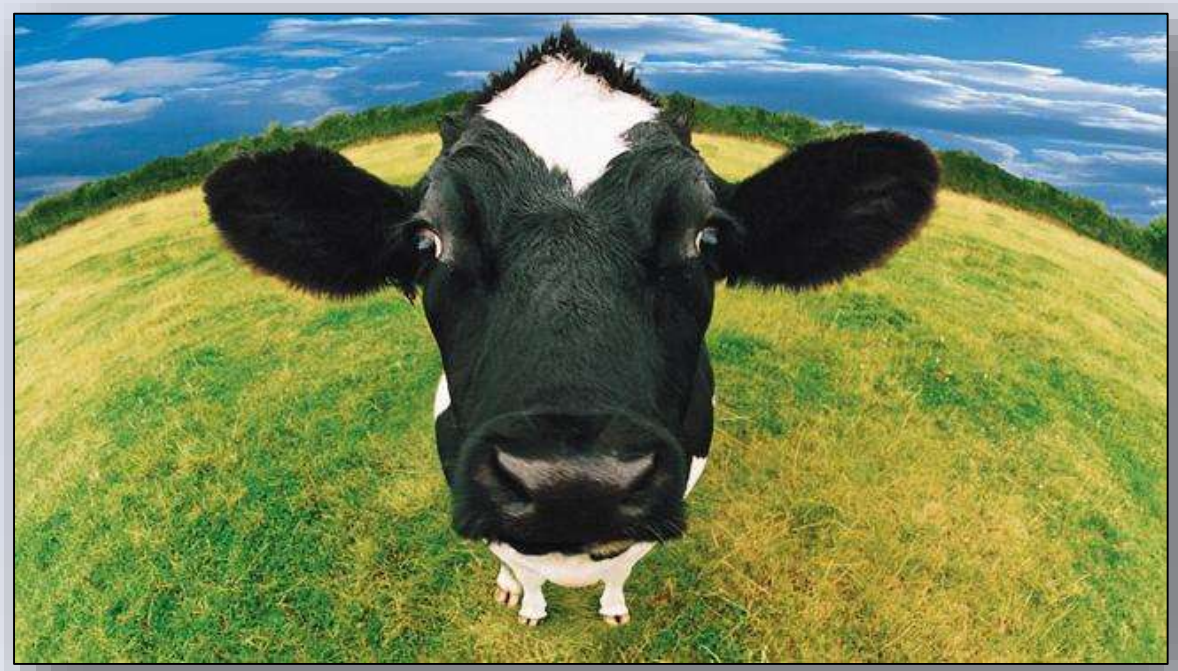
Conclusions & Implications

- 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!

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