TEXAS A&M AGRILIFE EXTENSION

http://sickcrops.tamu.edu

Wheat Fungicide Chemistry and Action

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November 30, 2016

http://sickcrops.tamu.edu

Texas AgriLife Research & Extension Center at AMARILLO

Plant Pathology Extension

Dr. Ronald French

Welcome to **SICK CROPS**

- Citrus
- Corn
- Potato
- Sorghum
- Bean/Soybean
- Vegetables
- Wheat
- Other Crops
- Homeowner/Gardeners

- **Contact Information**
- Wheat Disease Fact Sheets
- Plant Diagnostic Form
- Texas Plant Diagnostic Clinic (THPPDL)

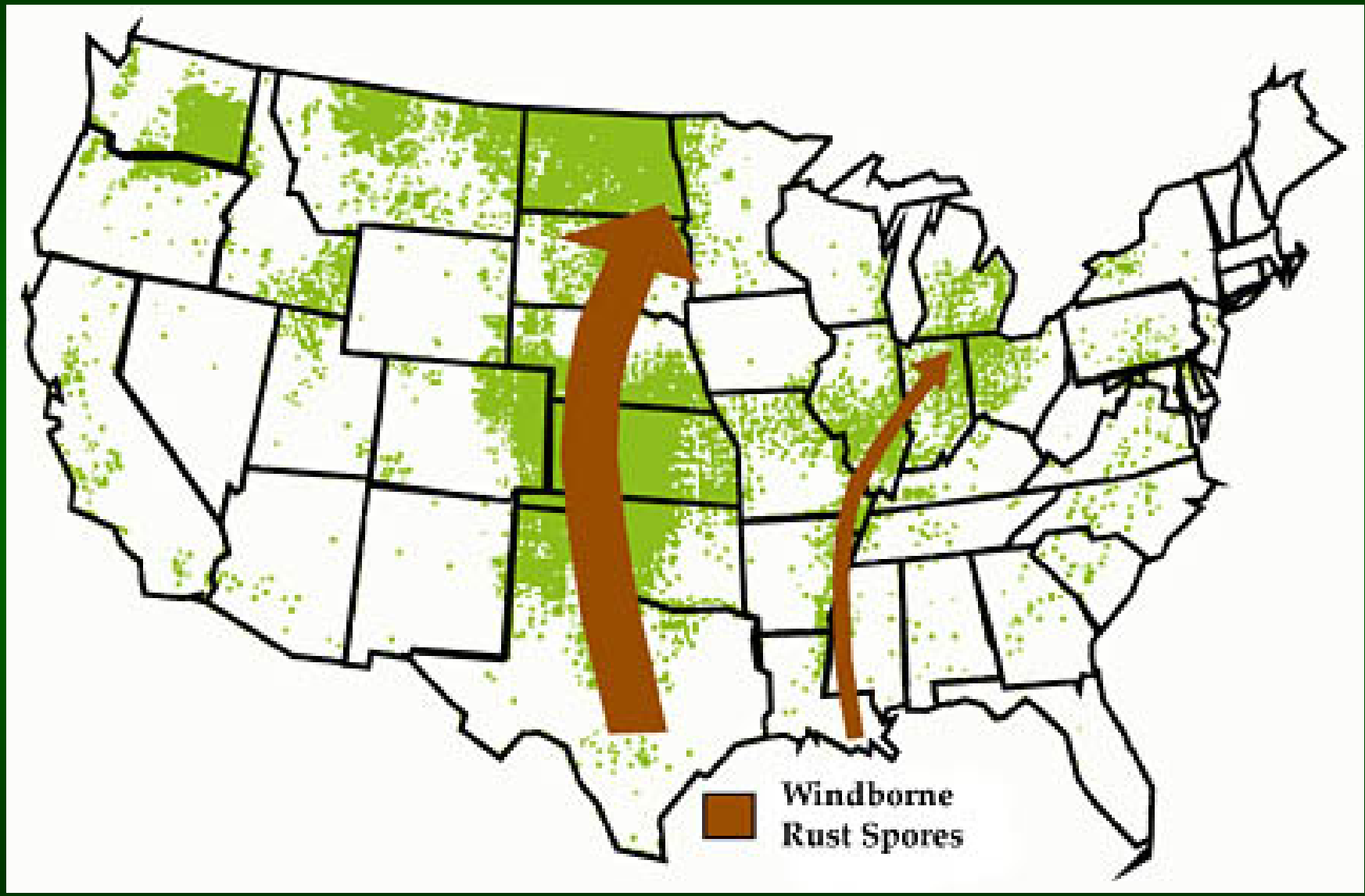
TEXAS PLANT DIAGNOSTIC CLINIC

(Texas High Plains Plant Diagnostic Laboratory)

Texas A&M AgriLife Research and Extension Center
6500 Amarillo Blvd. W
Amarillo, Texas 79106

http://plantdiagnostics.tamu.edu

SPRING Spore Dispersal



Stripe Rust (*Puccinia striiformis*)

Humidity and cool weather (45 F to 65 F) favors stripe rust; warmer temperatures can affect spore production

Stripe rust (Terry Co., 3/9/2016)

Tyler Mays

Leaf Rust (*Puccinia triticina*)

More active in the high 60s F to low 80s F. Fungus can survive at warmer temperatures.

Leaf rust (Coastal Bend, March 2)

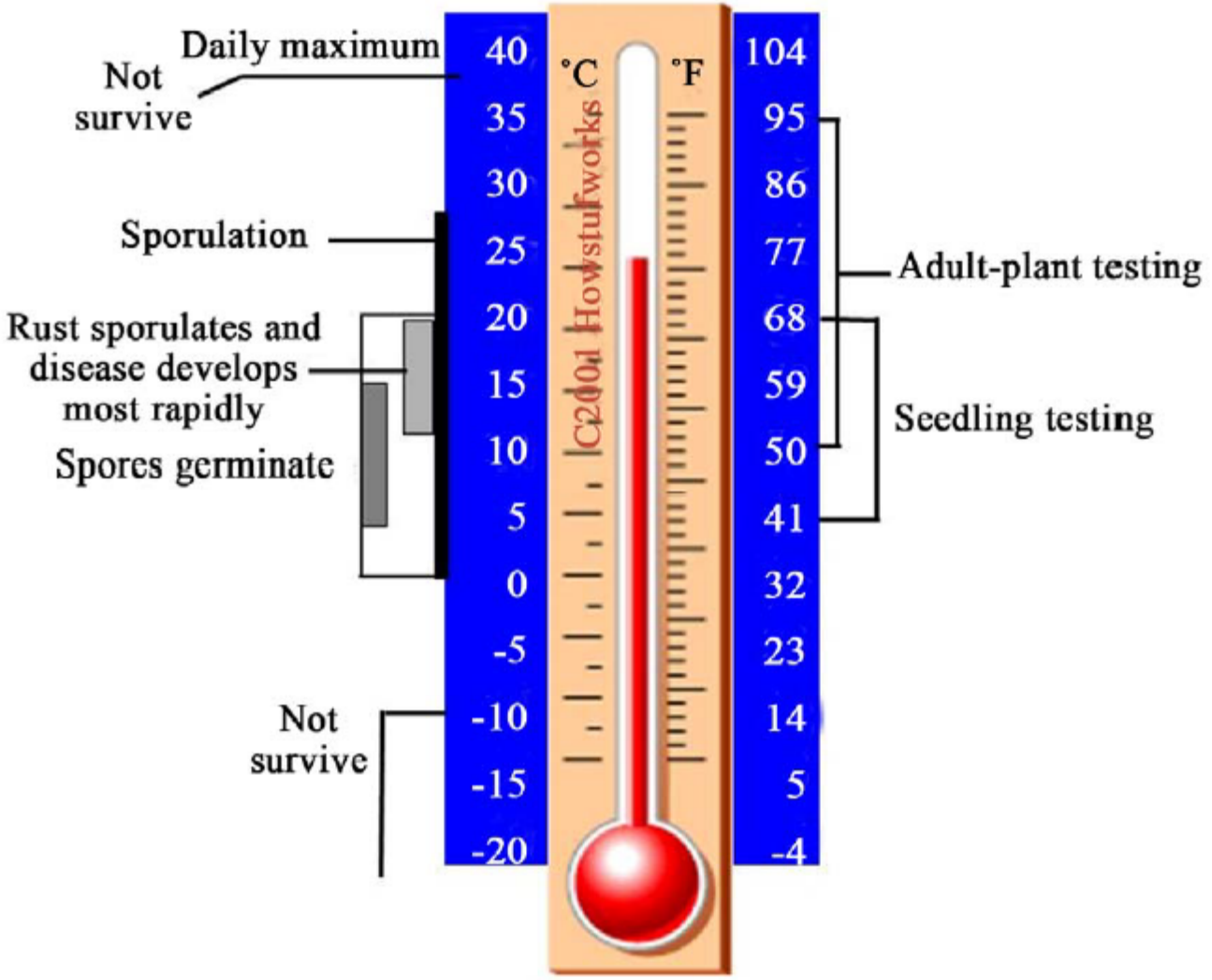


Figure 1. Ranges and optima of temperatures at which *Puccinia striiformis* germinates, sporulates and survives. The temperature ranges used for testing plants under low- and high-temperatures are shown at the right.

Cher

TEXAS A&M AGRILIFE EXTENSION

High Temperature Adult Plant Resistance

39 to 68 F **50 to 95 F**

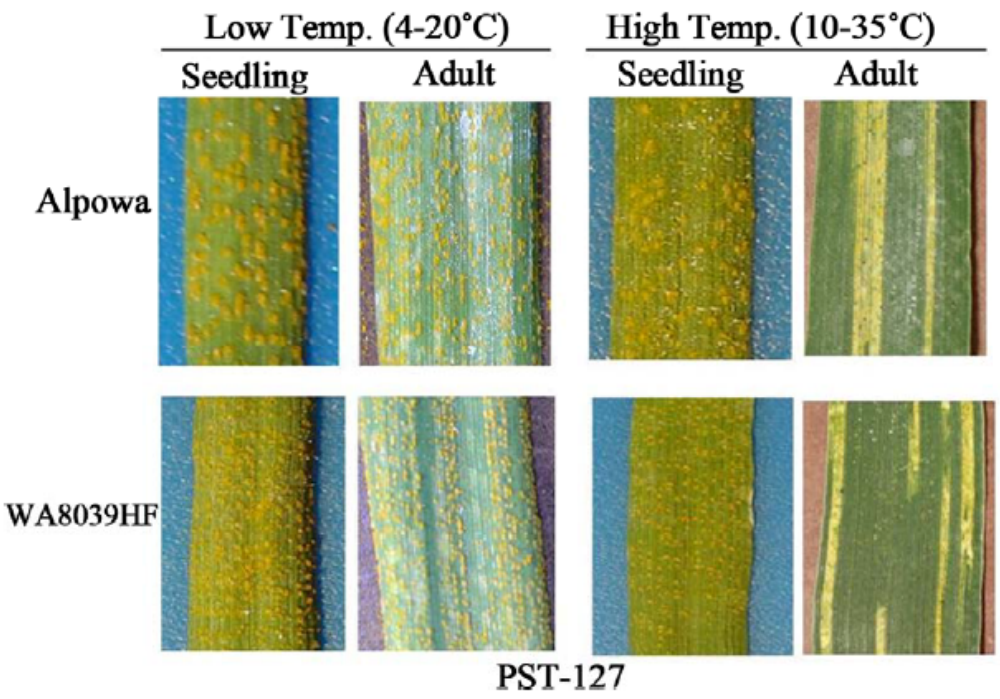


Figure 3. 4-way tests (seedling-low temperature, adult-low temperature, seedling-high temperature, and adult-high temperature) to detect high-temperature adult-plant (HTAP) resistance to stripe rust. Plants showing a resistant reaction only or mostly in the adult-plant stage at high-temperatures are identified to have HTAP resistance.

Chen, 2013

Texas A&M AgriLife Extension

Stripe Rust (leaf stripe,no pustules)

- Stripe rust on a wheat variety with adult plant resistance (little or no pustules)….
- Or… pustules not produced due to temperatures above 90 F (and mycelia dies out before spore formation)
- Or… wheat was sprayed with fungicide and fungus died before producing spores

Stripe Rust

- Age or varietal dependent, stripe rust can follow a linear or stripe pattern (variety moderately resistant to moderately susceptible), or may aggregate (ie. variety susceptible to moderately susceptible)

Stripe Rust

- Uredinial (orange spores) and telial (dark spore) stages of stripe rust. Telial pustules appear later in the crop season (may indicate shutdown of the disease) but with continouos cool and wet weather (in the day or night), the uredinial pustules aree still being produced and the disease cycle continues.

Flecking

- Physiological Leaf Flecking (genetic)
- Resistance to stripe (or leaf rust)- spore “lands” on a leaf and tries to penetrate but the plant fights back (ie. via a hypersensitive response, where leaf tissue around infection point by the germinating rust is killed).
- “Flecking” prior to seeing the red pustules.

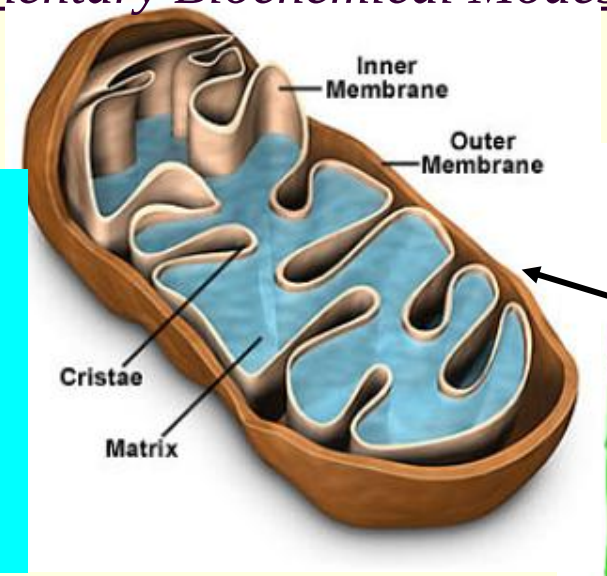
Xandra Morris

Fungicides labeled for wheat for the control of rusts in Texas: 2016

Product	Company	Rate per acre (fl. oz.)	Rusts Controlled	Pre-harvest interval (PHI) in days	Application Timing (as indicated by label)
***Bumper 41.8 EC, PropiMax EC, Tilt** (~41.8% propiconazole)	MANA, Dow AgroSciences, Syngena	4.0	Rusts (*Puccinia* spp.)	40	Applied until full head emergence (Feekes 10.5)
Caramba 0.75 SL (8.6% metconazole)	BASF	10.0 – 17.0	Leaf rust, Stripe rust, Stem rust (*Puccinia* spp.)	30	Apply after flag leaf emergence for optimum results
****Monsoon, Onset 3.6 L, Tebustar 3.6 L** (~38.7% tebuconazole)	Loveland Products Inc, AgriSolutions, Agri Star by Albaugh, Inc.	4.0	Rusts (*Puccinia* spp.)	30	Apply at earliest sign of rust pustules on foliage
Proline 480 SC (41% Prothioconazole)	Bayer CropScience LP	4.3- 5.0	Rusts (*Puccinia* spp.)	30	Preventative foliar spray at early flower (Feekes 10.51).
Aproach SC (22.5% Picoxystrobin)	Du Pont	6.0-12.0	Rusts (*Puccinia* spp.)	45	Apply no later than beginning of flowering (Feekes 10.5)
Headline SC (23.6% pyraclostrobin)	BASF	6.0-9.0	Leaf rust, Stripe rust, Stem rust (*Puccinia* spp.)	14 (hay)	Apply no later than beginning of flowering (Feekes 10.5)
Evito 480 SC (40.3% fluoxastrobin)	Arysta LifeScience North America, LLC	2.0-4.0	Leaf rust, Stripe rust, Stem rust (*Puccinia spp.*)	40	From Feekes 5 (leaf sheaths strongly erect) up to late head emergence (Feekes 10.5)
Quadris (22.9% azoxystrobin)	Syngenta	4.0-12.0	Leaf rust, Stripe rust, Stem rust (*Puccinia* spp.)	45	Do not apply after Feekes 10.54 (~flowering completed)
Priaxor (14.3% Fluxapyroxad + 28.6% Pyraclostrobin)	BASF	4.0-8.0	Leaf rust, Stripe rust, Stem rust (*Puccinia spp.*)	-	Apply no later than beginning of flowering (Feekes 10.5)
Absolute 500 SC (22.6% Tebuconazole + 22.6% Trifloxystrobin)	Bayer CropScience LP	5.0	Rusts (*Puccinia* spp.)	35	No more than 5 fl. oz. per season
Aproach Prima SC (17.94% picoxystrobin + 7.17% cyproconazole)	Du Pont	3.4-6.8	Leaf rust, Stripe rust, Stem rust (*Puccinia* spp.)	45	For optimizing yield and flag leaf disease control, apply at Feekes 9 ('flag leaf out')
Prosaro 421 SC (19% prothioconazole + 19% tebuconazole)	Bayer CropScience LP	6.5 -8.2	Rusts (*Puccinia* spp.)	30	Until mid-flowering when 75-100% heads fully emerged and 50% of heads on main stem in flower (Feekes 10.52)
Fortix (14.84% fluoxastrobin + 19.3% flutriafol)	Arysta LifeScience	4.0-6.0	Rusts (*Puccinia* spp.)	40	Applied through full head emergence (Feekes 10.5)
Quilt Xcel (13.5% azoxystrobin + 11.7% propiconazole)	Syngenta	10.5- 14.0	Rusts (*Puccinia* spp.)	45	Applied when the flag leaf is 50% to fully emerged and until full head emergence (Feekes 10.5)
Stratego YLD (32.3% trifloxystrobin + 10.8% prothioconazole)	Bayer CropScience LP	4.0	Rusts (*Puccinia* spp.)	35	Do not apply after Feekes growth stage 10.5 (full head emergence)
TwinLine 1.75 EC (12% pyraclostrobin + 7.4% metconazole)	BASF	7.0-9.0	Rusts (*Puccinia* spp.), Stripe rust (*Puccinia striiformis*)	30	Apply no later than the beginning of flowering (Feekes 10.5)
Trivapro [combination of Trivapro A (10.27% Benzovindiflupyr); Trivapro B (13.5% azoxystrobin + 11.7% propiconazole)]	Syngenta	4.0; 10.5	Rust (Puccinia spp.)	Feekes 10.5.4; Feekes 10.5	Spring early disease control, Feekes 8 to 10.5.4 (kernel watery ripe) Flag leaf 50% to fully emerged through full head emergence (Feekes 10.5)
Custodia (11.00% azoxystrobin + 18.35% tebuconazole)	MANA	6.4-8.6	Leaf, stem, and stripe rust (*Puccinia* spp.)	45	At earliest sign of rust pustules up to late head emergence (Feekes 10.5)

Foliar Fungicides- Strobilurin + Triazole:

Two Complimentary Biochemical Modes of Action

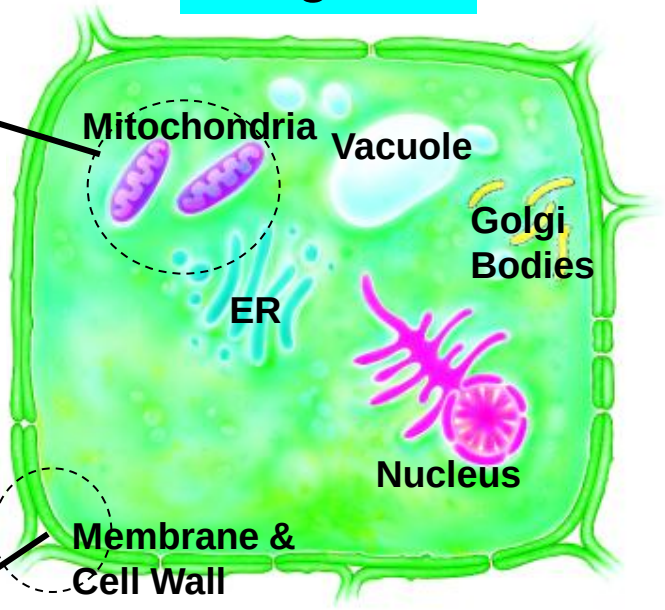


Strobilurin

Inhibits electron transfer in cytochrome bc1 complex of mitochondria. Therefore, disrupts energy production by the fungus.

Good preventative action!

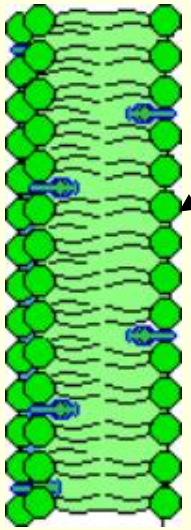
Fungal cell



Triazole

Inhibits sterol biosynthesis. Sterols are important components of the cell membrane.

Good post-infection activity!



..... also beneficial for resistance management

Courtesy Syngenta (modified)

Triazoles

- Triazoles “inhibit sterol biosynthesis” where sterols are important for the cell membrane. In other words, they affect the growing fungus (mycelium) and the fruiting structures that produce the spores.
- Triazoles cannot target the spore as it has its own energy source (the mitochondria) which allows it to germinate and penetrate a plant leaf. They can be more locally systemic, so they can travel within the leaf but not from one leaf to another.
- Examples include: tebuconazole (Monsoon, Tebustar), propiconazole (Tilt 3.6 EC), Prothioconazole (Proline 480 SC), and metconazole (Caramba 0.75 SL)
- Approximately two weeks of protection (could be more, could be less)

Strobilurins

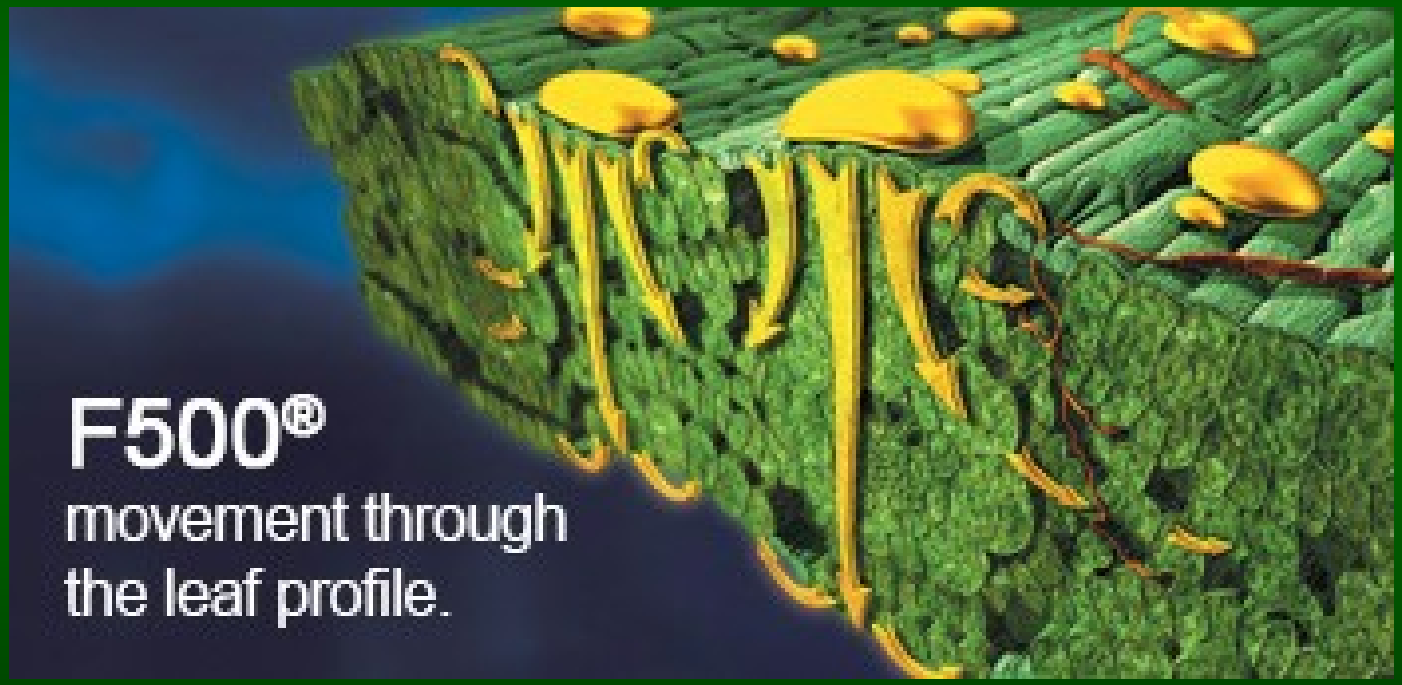
- Strobilurins (part of the Qo inhibitors –QoI- or quinone outside inhibitors and originally extracted from the fungus Strobilurus tenacellus) "inhibit electron transfer in cytochrome bc1 complex of the mitochondria". Or in other words, affects the energy source for the fungus and respiration. It can therefore prevent spore germination and thus, infection.

- Examples include Picoxystrobin (Aproach SC), Fluoxastrobin (Evito 480SC), and Pyraclostrobin (Headline 2.09 EC), and Trifloxystrobin (found in Stratego YLD, which has a mixed mode of action).

- Two to three week protection (could be more or less).

Translaminar movement

- Pyraclostrobin



Strobilurins

- Most are translaminar (movement across the leaf blade) but may have varying degrees of systemic activity. For example, azoxystrobin can move systemically (via xylem) but trifloxystrobin is considered “quasi-systemic” (not via xylem, but limited as a gas along the leaf surface).

- Mixed Mode of Action (Strobilurin plus Triazole such as Quilt Xcel)-can be useful because it may go into the plant’s vascular system, spread up and down the leaf (both active ingredients systemic)

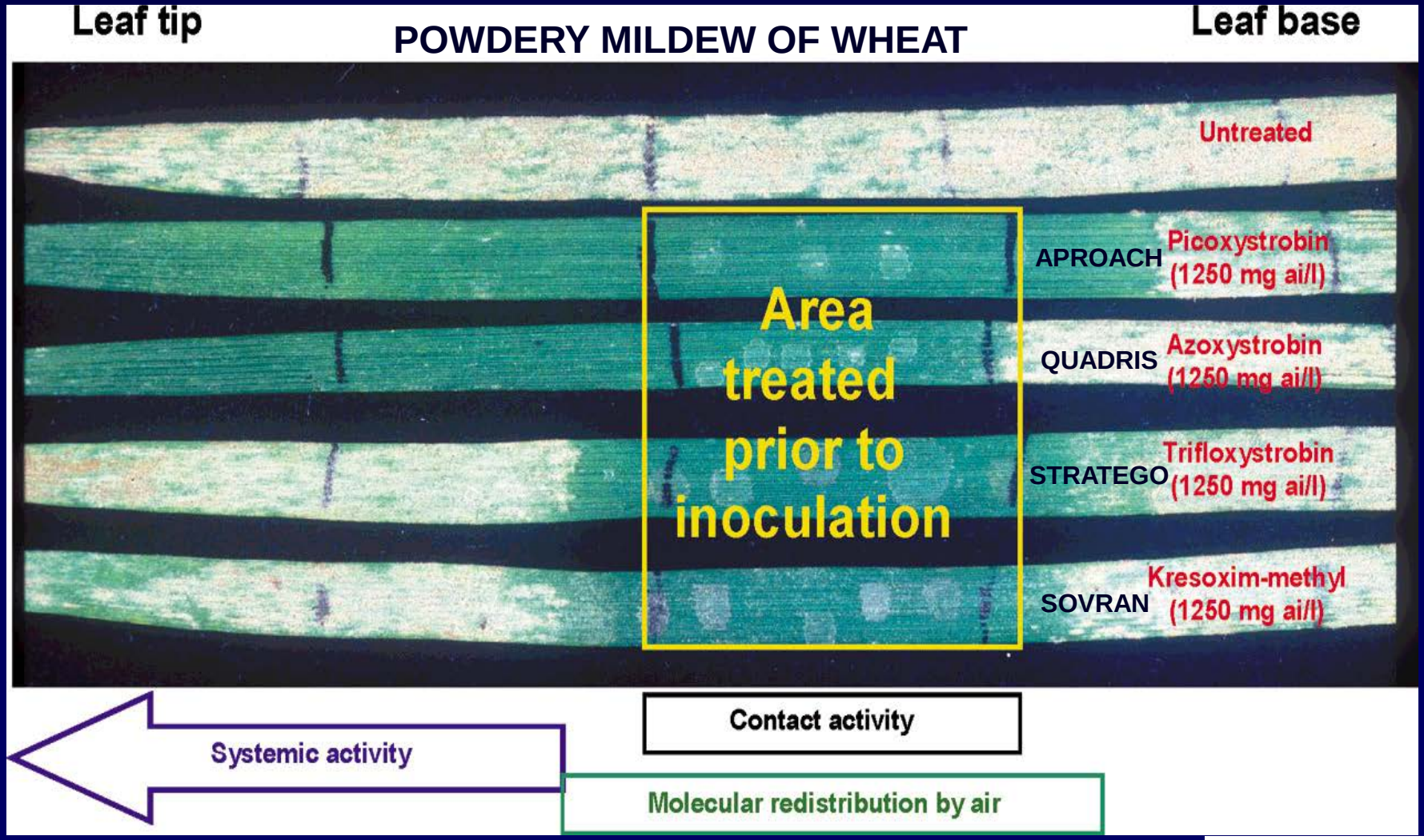
- Two triazole combination: some can have a faster initial activity (i.e. tebuconazole, propiconazole), while others may have a longer duration/residual activity (i.e. prothioconazole)

Triazoles and Strobilurins (translaminar): 4 groups

- **Moderate** translaminar movement/**small zone** of control (pyraclostrobin, fluoxastrobin)
- **Moderate** translaminar movement/**large zone** of control (propiconazole, epoxiconazole, tebuconazole)
- **Strong** translaminar movement/**large zone** of control (picoxystrobin, fenbuconazole, myclobutanil, prothioconazole)
- **Very strong** translaminar movement/**large zone** of control (cyproconazole, azoxystrobin).

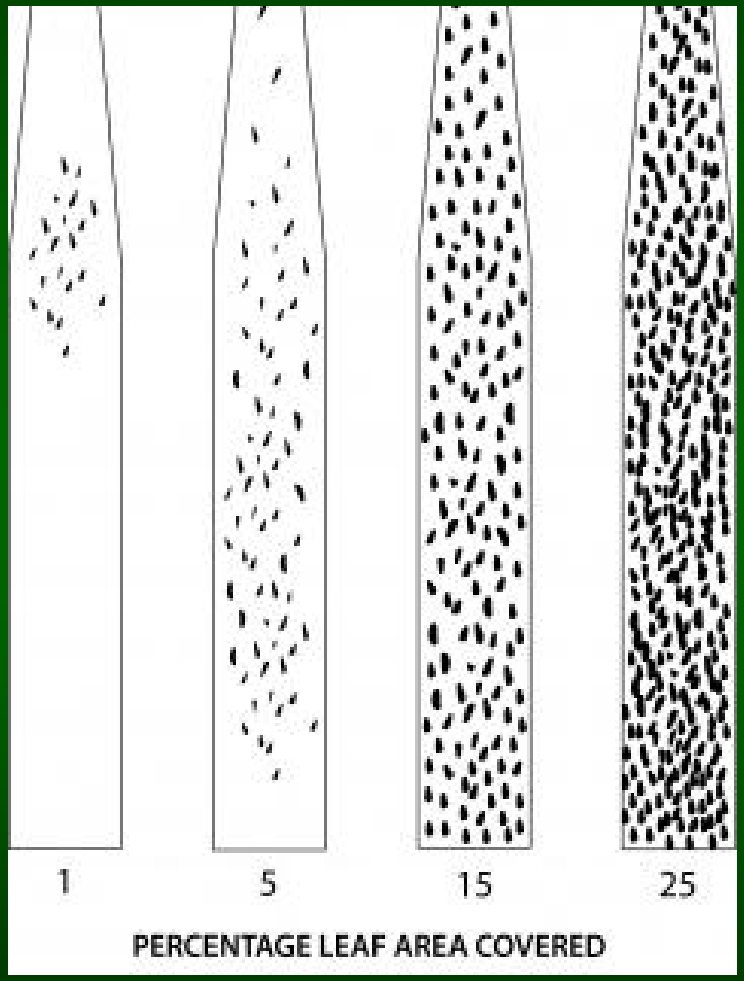
Klittich and Ray, 2014. Effects of chemical class and physical properties on thetranslaminar activity of fungicides. (Cucumber Powdery Mildew)

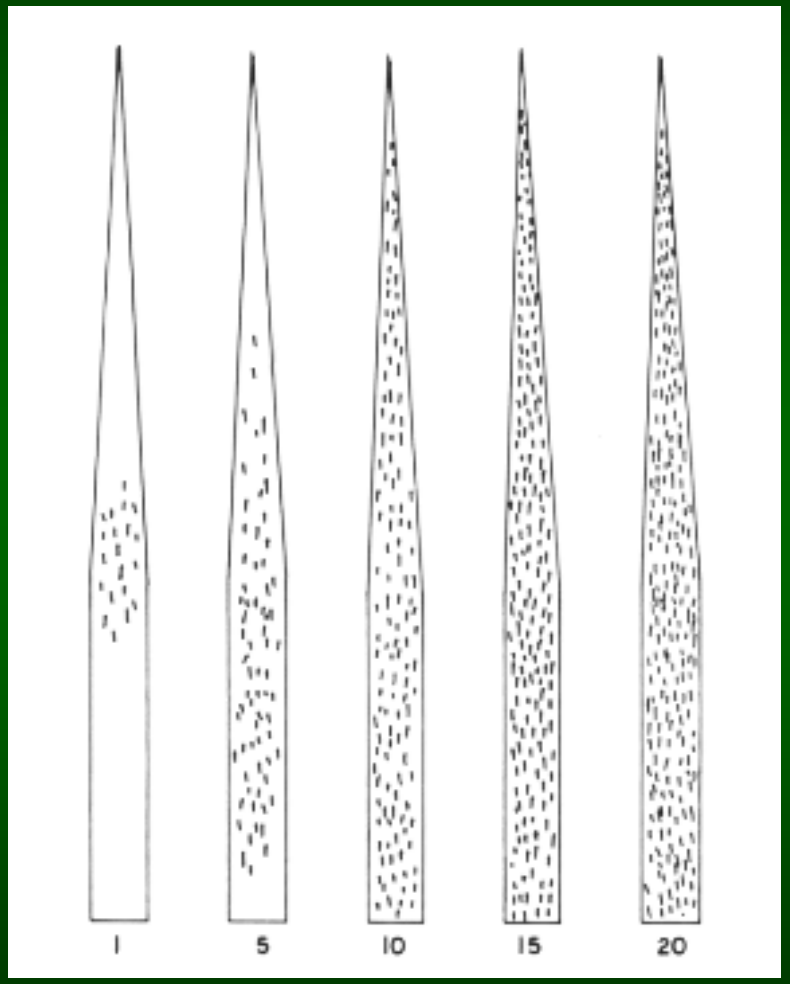
Redistribution of some strobilurins



Azoxystrobin –high translaminar movement; Picoxystrobin & Azoxystrobin-xylem systemic; (Bartlett et al, 2002)

Leaf area covered by leaf rust (%)





Cobb scale; modified

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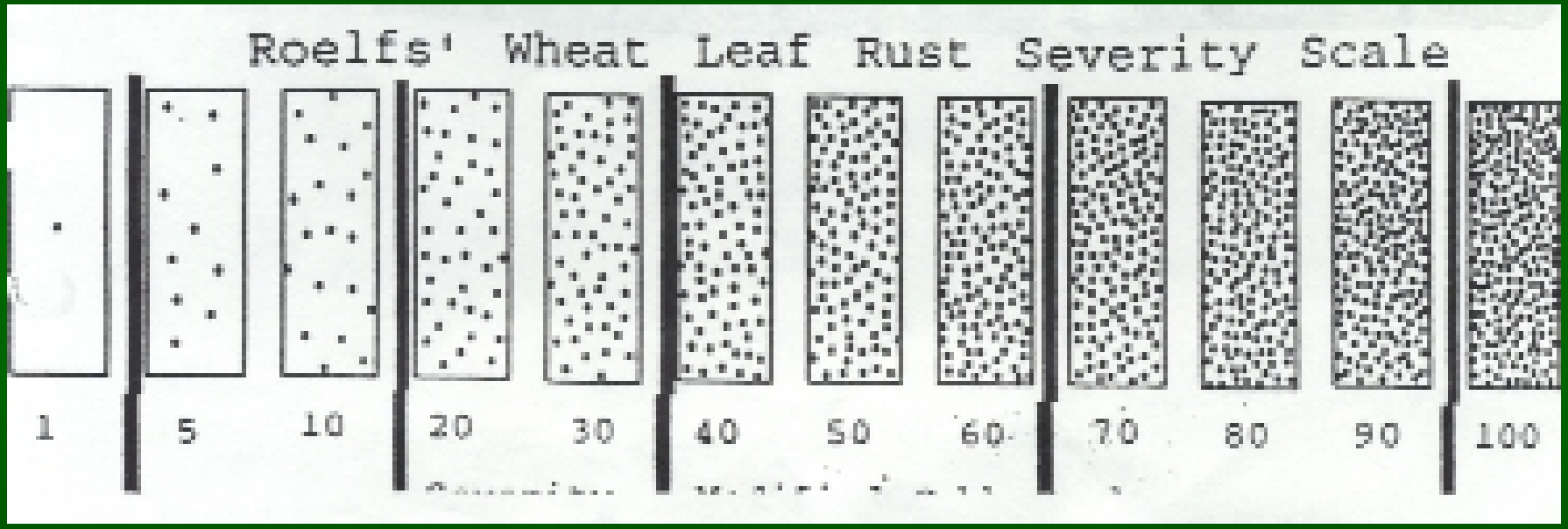
Leaf area covered by leaf rust (~10%)

Severity (more representative of damage)



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RUST THRESHOLD: Disease Management for Leaf Rust

Approximate percent loss of yield caused by leaf rust at combinations of leaf rust severity and growth stage of wheat.

	Severity (%) of leaf rust on the flag leaf				
	10	**25**	**40**	**65**	**100**
Growth stage	----------Yield Loss (%)----------				
FLOWERING	**10**	**15**	**20**	**30**	**35**
Milk	2	5	8	14	20
Soft dough	1	3	4	7	10
Hard dough	1	1	1	3	5

Chester, 1946 (modified); Edwards and Hunger, 2007

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Leaf area covered by stripe rust (~10%)

Disease Management for Stripe Rust

Potential Loss of Yield (%) from Stripe Rust based on Growth Stage of Wheat and Host Susceptibility. **Z**=Zadoks Decimal Growth Scale **F**=Feekes Growth Stage

Start of Epidemic (Epiphytotic)	Percentage Loss in Crop based on Host Susceptibility			
	S(2)	MS(4)	MR(6)	R(8)
First Node (Z31; F6)	85	75	55	25
Flag leaf (Z39; F9)	75	45	15	5
Mid-boot (Z45; F10)	65	25	7	2
First awns visible; First Spikelet of Inflorescence Barely Visible (Z49; between F10-10.1)	50	10	3	1
Mid-heading, half of inflorescence emerged (Z55; F10.3)	40	5	2	0
Mid-flowering; Anthesis half way (Z65; 10.52)	12	2	1	0

S=Susceptible MS=Moderately Susceptible MR= Moderately Resistant R=Resistant
Source: Gordon Murray, NSW DPI, Wagga Wagga, New South Wales, Australia.

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2016 AgriLife “Pick” Varieties

Full Irrigation	Limited Irrigation	Dryland
TAM 304	TAM 111 (S/S)	TAM 111
	TAM 112 (S/S)	TAM 112
TAM 113 (R/R)	TAM 113	TAM 113
TAM 114 (MR/R)	TAM 114	TAM 114
WB Grainfield (MR/R)	WB Grainfield	WB Grainfield
Iba (R/R)	Iba	Iba
	T158 (MS/MR)	T158
Winterhawk (MS/MR)	Winterhawk	Winterhawk

R = Resistant **MR = Moderately Resistant**

MS = Moderately Susceptible **S = Susceptible**

Jourdan Bell

2016 Fungicide Trial Targeting Stripe Rust
Booker, Texas
(Scott Strawn, JR Sprague, Jourdan Bell)

- **Variety**: Ruby Lee
- **Application Dates:** April 22, 2016 (early heading) and May 6, 2016 (late flower)
- **Application Volume:** 15 GPA
- **Products:**
  - Trivapro SE (10.27% Benzovindiflupyr, 13.5% Azoxystrobin + 11.7% Propiconazole)
  - Priaxor 4.17 SC (14.3% Fluxapyroxad + 28.6% Pyraclostrobin)
  - Quilt Xcel 2.2 SE (13.5% Azoxystrobin + 11.7% Propiconazole)

April 22, 2016: Full Rate Plots

Treatment #	Product	Rate
1	Untreated Check	
2	Trivapro SE + COC	14.5 fl oz/ac
3	Priaxor 4.17 SC	7.8 fl oz/ac
4	Quilt Xcel 2.2 SE + COC	7.4 fl oz/ac

April 22, 2016: Half Rate Plots

Treatment #	Product	Rate
1	Untreated Check	
2	Trivapro SE + COC	7.25 fl oz/ac
3	Priaxor 4.17 SC	3.9 fl oz/ac
4	Quilt Xcel 2.2 SE + COC	3.7 fl oz/ac

May 6, 2016: Full Rate Plots

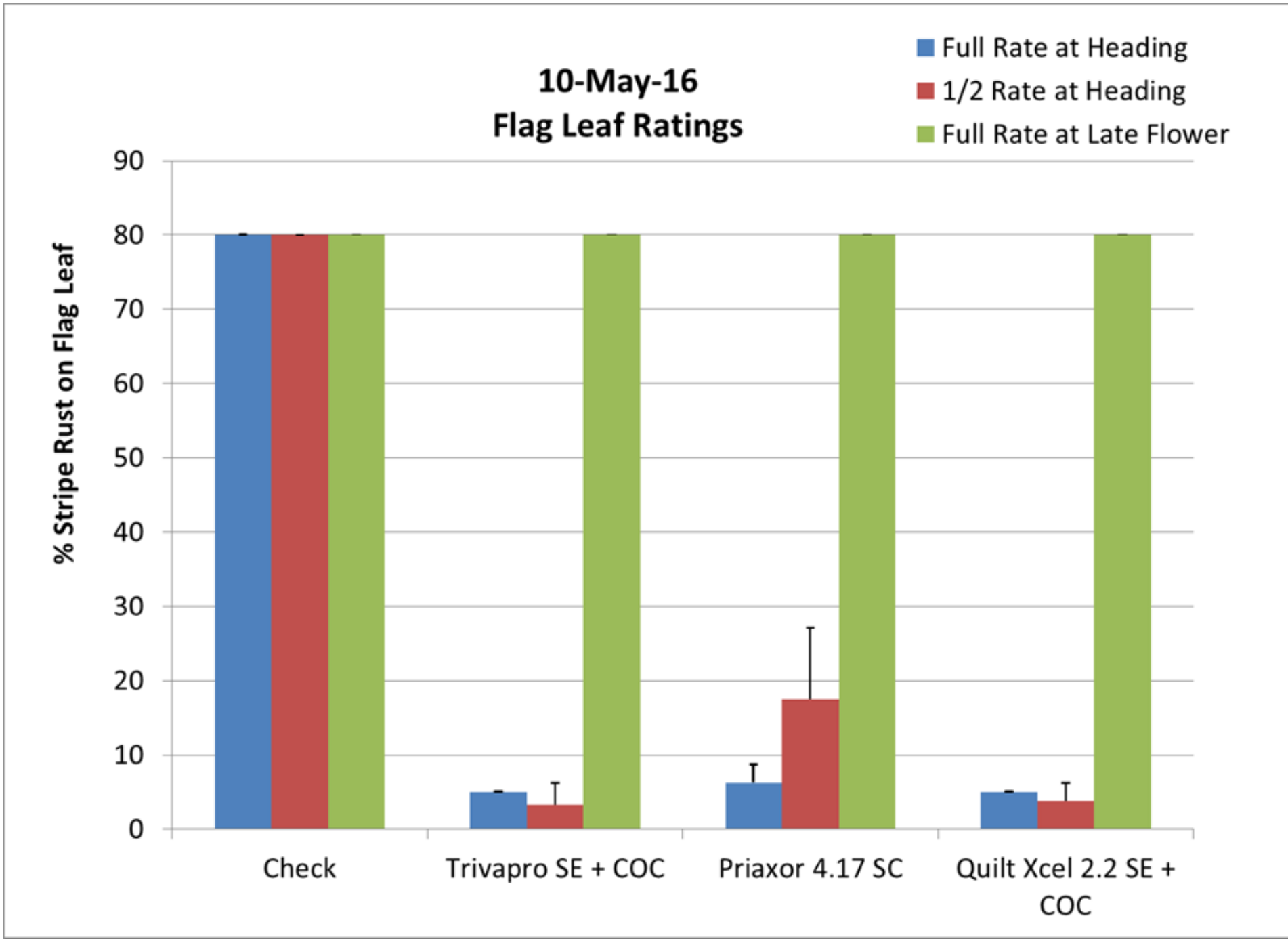
Treatment #	Product	Rate
1	Untreated Check	
2	Trivapro SE + COC	14.5 fl oz/ac
3	Priaxor 4.17 SC	7.8 fl oz/ac
4	Quilt Xcel 2.2 SE + COC	7.4 fl oz/ac

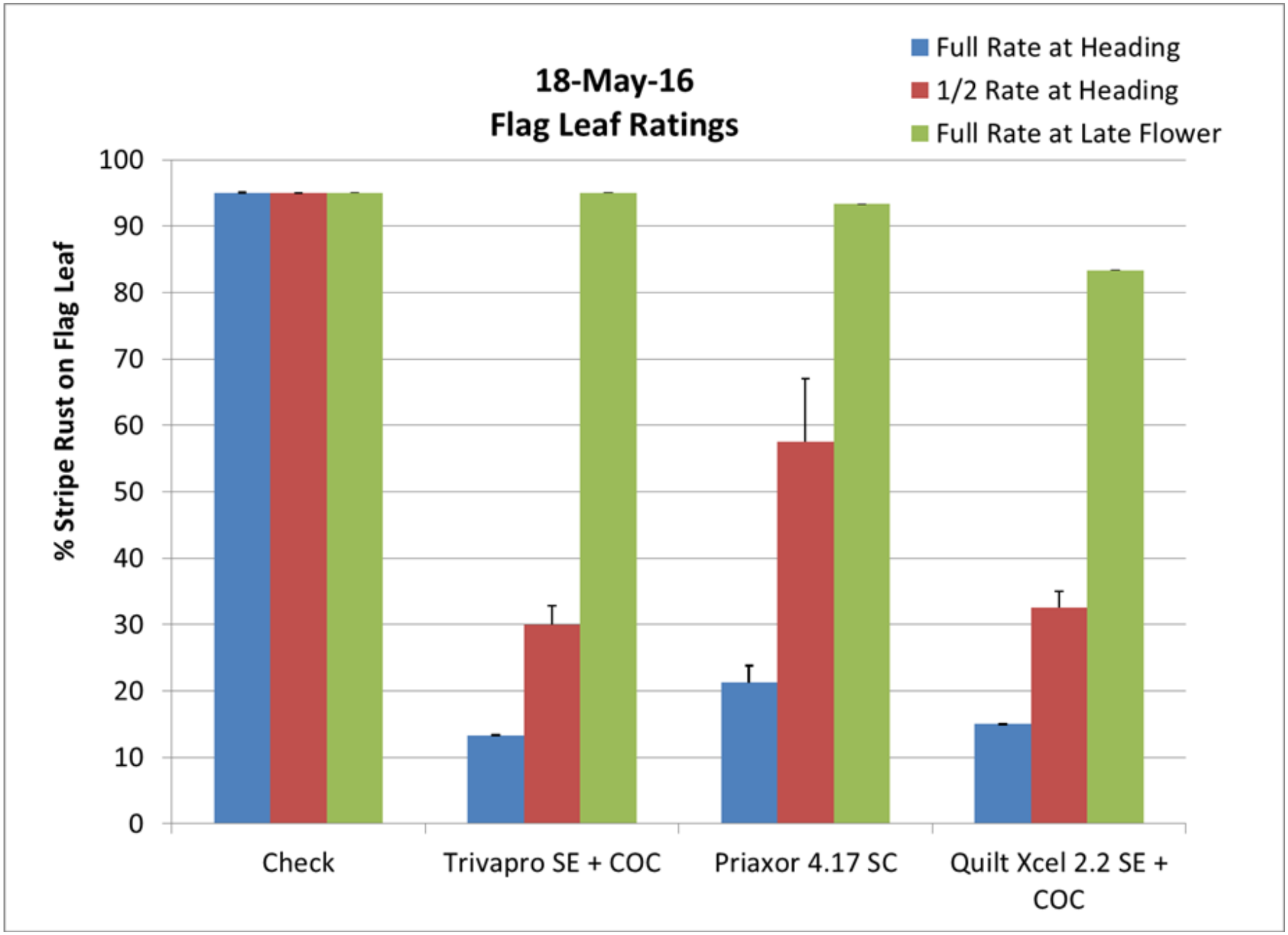
May 6, 2016: Sprague and Strawn Plots

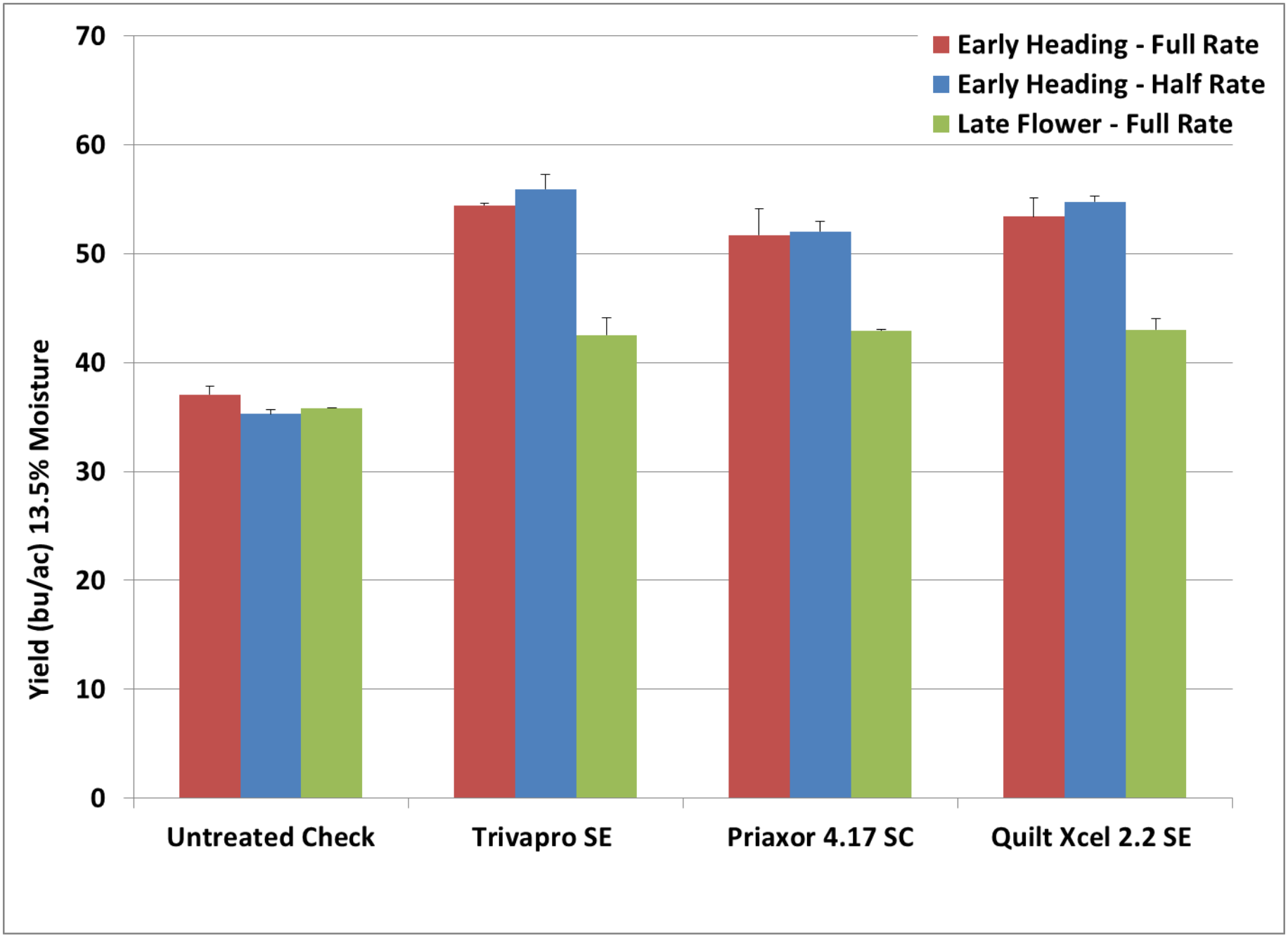
Treatment #	Product	Rate
1	Untreated Check	
2	Tebuconazole + Propiconazole	4.00 fl oz/ac + 2.0 fl oz/ac

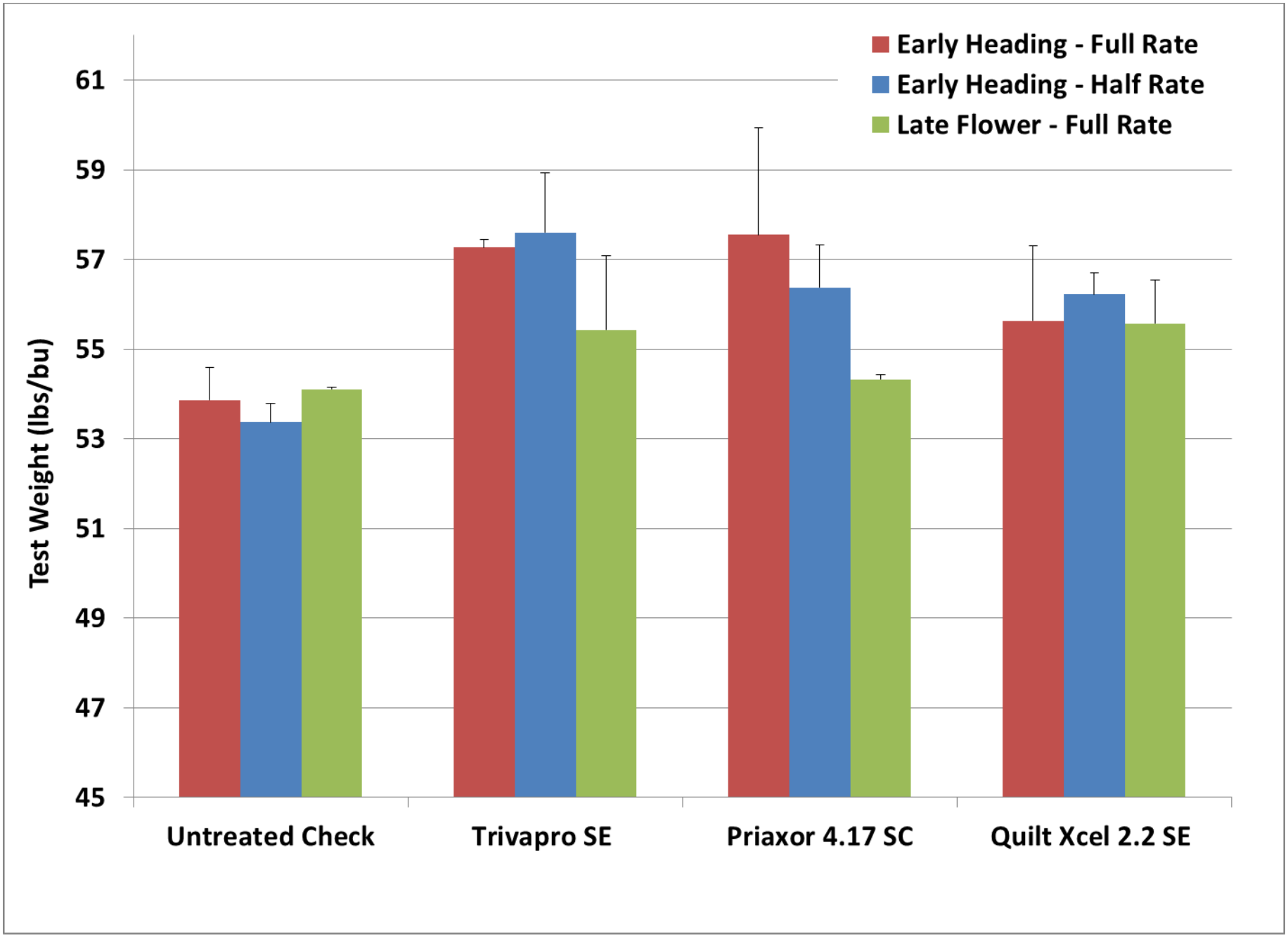
Notes:

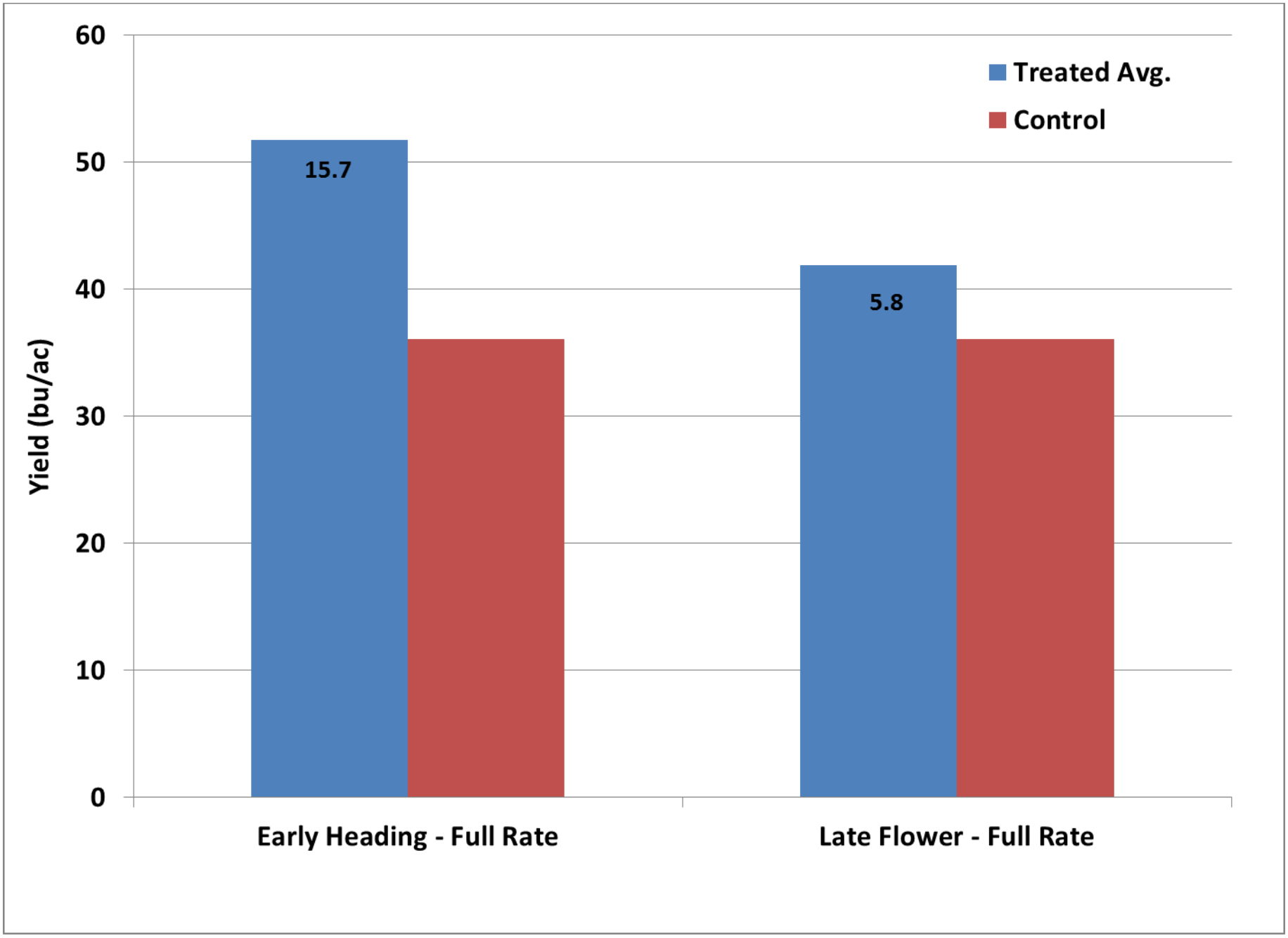
None of the products are recommended for late flower.


10-May-16
Flag Leaf Ratings
Full Rate at Heading
1/2 Rate at Heading
Full Rate at Late Flower
% Stripe Rust on Flag Leaf
90
80
70
60
50
40
30
20
10
0
Check
Trivapro SE + COC
Priaxor 4.17 SC
Quilt Xcel 2.2 SE + COC


18-May-16
Flag Leaf Ratings
Full Rate at Heading
1/2 Rate at Heading
Full Rate at Late Flower
% Stripe Rust on Flag Leaf
100
90
80
70
60
50
40
30
20
10
0
Check
Trivapro SE + COC
Priaxor 4.17 SC
Quilt Xcel 2.2 SE + COC


Early Heading - Full Rate
Early Heading - Half Rate
Late Flower - Full Rate
Yield (bu/ac) 13.5% Moisture
70
60
50
40
30
20
10
0
Untreated Check
Trivapro SE
Priaxor 4.17 SC
Quilt Xcel 2.2 SE


Early Heading - Full Rate
Early Heading - Half Rate
Late Flower - Full Rate
Test Weight (lbs/bu)
61
59
57
55
53
51
49
47
45
Untreated Check
Trivapro SE
Priaxor 4.17 SC
Quilt Xcel 2.2 SE


60
50
40
30
20
10
0
Yield (bu/ac)
Treated Avg.
Control
15.7
5.8
Early Heading - Full Rate
Late Flower - Full Rate

Bushland, TX 2016 (Ron French)

Trt#	Treatment[z] (fl oz/A in 15 GPA) on TAM 204 (moderately resistant to stripe rust, moderately susceptible to leaf rust)	Application Timing[y]	Stripe Rust % Severity (Flag Leaf) 16 May	Rust and F. spp. % Severity (Lower canopy) 16 May	Yield (bu/A)
1	Non-treated (Untreated Check)	-	**35.0 a[w]**	53.8 a[w]	**45.3 a[w]**
2	Monsoon-local standard tebuconazole (4)	F10.5[x]	16.3 b	31.3 b	45.1 a
3	Quilt Xcel 2.2 SE (7), Trivapro SE (13.7)	F2, F10.5	18.8 b	28.8 b	45.4 a
4	Trivapro SE (9.4), A21573-A (11.4)	F2, F10.5+5d	**12.5 c**	32.5 b	44.9 a
5	Trivapro SE (13.7)	F10.5	16.3 b	35.0 b	**48.6 a**
6	A21461 (10.3)	F10.5	12.5 c	30.0 b	48.4 a
7	A21461 (13.7)	F10.5	10.0 c	35.0 b	43.3 a
8	A21573-A (11.4)	F10.5	10.0 c	28.8 b	47.6 a
9	A21573-A (11.4)	F10.5+5d	12.5 c	28.8 b	41.6 a
10	A15457-K (4.1)	F10.5	10.0 c	36.3 b	43.6 a
11	A15457-R (4.1)	F10.5	12.5 c	33.8 b	41.7 a
	LSD		3.60	7.94	12.46

[z] Products separated by a comma were applied at different timings. Application rates are in parentheses.
[y] Refers to wheat growth stage according to the Feekes scale (F2=tillering, F10.5=fully headed)
[x] F2 spray date= 3 Mar 2016, F10.5 spray date=28 Apr, F10.5 + 5days= 2 May
[w] Means followed by the same letter in the same column are not statistically different based on Fisher's Least Significant Difference (L.S.D.) at P=0.05

Bushland, TX 2016 (Ron French)

Trt#	Treatment[z] (fl oz/A in 15 GPA) on TAM 204 (moderately resistant to stripe rust, moderately susceptible to leaf rust)	Application Timing[y]	Stripe Rust % Severity (Flag Leaf) 16 May	Rust and F. spp. % Severity (Lower canopy) 16 May	Yield (bu/A)
1	Non-treated (Untreated Check)	-	**35.0 a[w]**	53.8 a[w]	**45.3 a[w]**
2	Monsoon-local standard tebuconazole (4)	F10.5[x]	16.3 b	31.3 b	45.1 a
3	Quilt Xcel 2.2 SE (7), Trivapro SE (13.7)	F2, F10.5	18.8 b	28.8 b	45.4 a
4	Trivapro SE (9.4), A21573-A (11.4)	F2, F10.5+5d	**12.5 c**	32.5 b	44.9 a
5	Trivapro SE (13.7)	F10.5	16.3 b	35.0 b	**48.6 a**
6					
7					
8					
9					
10					
11					
	LSD		3.60	7.94	12.46

[z] Products separated by a comma were applied at different timings. Application rates are in parentheses.
[y] Refers to wheat growth stage according to the Feekes scale (F2=tillering, F10.5=fully headed)
[x] F2 spray date= 3 Mar 2016, F10.5 spray date=28 Apr, F10.5 + 5days= 2 May
[w] Means followed by the same letter in the same column are not statistically different based on Fisher's Least Significant Difference (L.S.D.) at P=0.05

Can I spray a triazole?

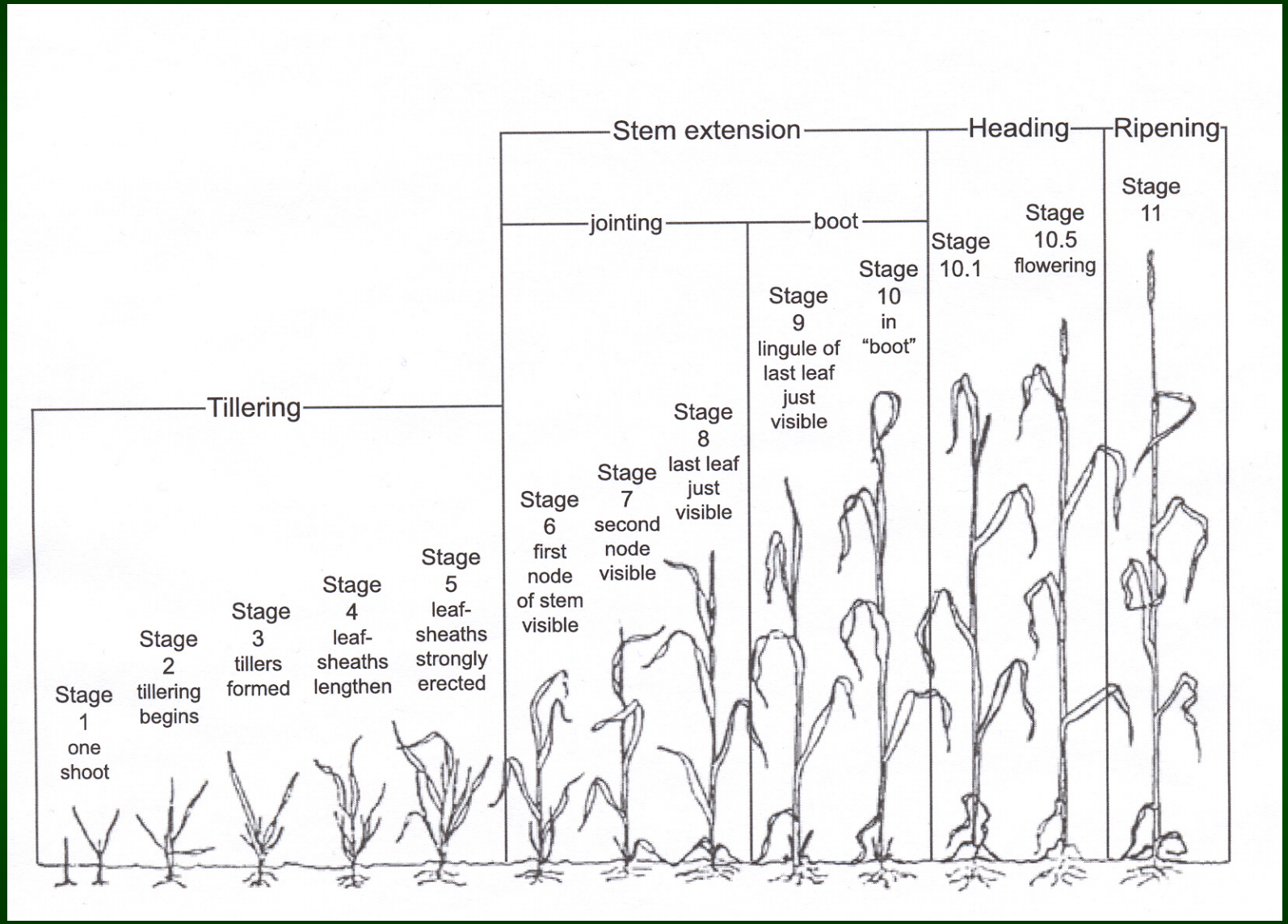
- The key is coverage: as much leaf and plant tissue should be sprayed to assure uniform leaf protection.
- If blades are upright (perpendicular), both sides of the leaf will be sprayed, fungicide will go to lower canopy
- Target of fungicide will be actively growing fungus on leaf from original spore germination; triazole also **affects future spore production, <u>not the spore.</u>**

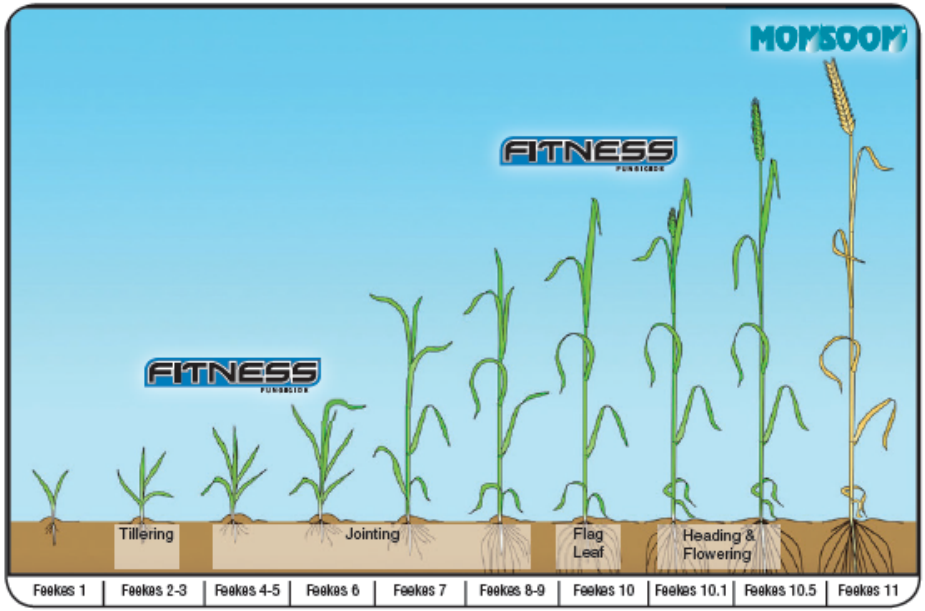
Stripe rust in lower leaves (TAM 113)

TAM 113

Texas A&M AgriLife Extension

Growth Stages of Wheat (Feekes Scale)





TIMING:	*Herbicide Timing (Feekes 2-6)*	*Flag Leaf (Feekes 10) 50-70% emergence*	*Heading (10% lower; Feekes 10.51)*
PRODUCT:	*FITNESS*	*FITNESS*	*MONSOON®*
RATE:	*2 oz*	*4 oz*	*4 oz*

- Note: Rusts are not mentioned in label for early disease suppression (2-4 fl oz/A)

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EXTENSION

Application timing

- Under “normal” years, application timing may not be as critical.
- Early timing (flag leaf emergence, or before) can provide more protection than when heads are emerging or later.
- When disease pressure is high early on, spraying can make the difference.
- Chemical may not be as critical as leaf coverage.
- If spore inoculum in the field is high (and in lower canopy) and/or coming from other fields, spraying a mixed mode of action may be well warranted.

Rainfall during 2014-2015 season (Amarillo*)

- October 2014: 1.08 inches (0.58 in. below normal)
- November 2014: 0.34 inches (0.46. in below normal)
- December 2014: 0.14 inches (0.59 in. below normal)
- January 2015: 2.42 inches (0.78 in. above normal)
- February 2015: 0.65 inches (1.09 in. below normal)
- March 2015: 1.82 inches (0.53 in. below normal)
- **April 2015: 2.61 inches (2.61 in. above normal)**
- **May 2015: 11.05 inches (6.92 in. above normal)**
- **June 2015: 4.38 inches (0.85 inches above normal)**

***utilizes Amarillo National Weather Service Data; some parts of Amarillo may have received more, or less rainfall than stated.**

TEXAS A&M AGRILIFE EXTENSION

Stripe rust

If spores are prevalent early on, this is an indication that spraying should take place or should have taken place….

Stem rust

Leaf rust

TEXAS A&M AGRILIFE EXTENSION

Parameters for spraying decision

- 1) Weather and rainfall or dew
- 2) Variety of wheat (what resistance?)
- 3) Yield potential
- 4) Expecting a better crop yield?
- 5) Type of irrigation (overhead, furrow, dryland)
- 6) Other diseases (potentially) present (powdery mildew, FHB)
- 7) Leaf stage for wheat (younger plants>losses)
- 8) Disease forecast (up to 10 day)
- 9) Historical weather
- 10) Pustules being observed in the field… or flecking (check for pustules at least 3-4 days later or before)
- 11) Is the rust in lower leaves or upper leaves or both?
- 12) Can I afford to gamble? (worth to spray cheaper, one mode of action fungicide?) Also, extra inch of rain early= 3 extra bu?

TEXAS A&M AGRILIFE EXTENSION

Integrated Rust Disease Management in Wheat

- Resistant Varieties to the Major Disease(s).
- Scouting for rust, find out what is going south of you (nearby, 100 miles south)
- Timing of fungicide sprays.
- Choose the right fungicides (spores vs fungal growth)
- Estimate your yield potential (is it worth spraying. If yield loss is 5% on 50 bu/a potential yield, only 2.5 bushels are lost

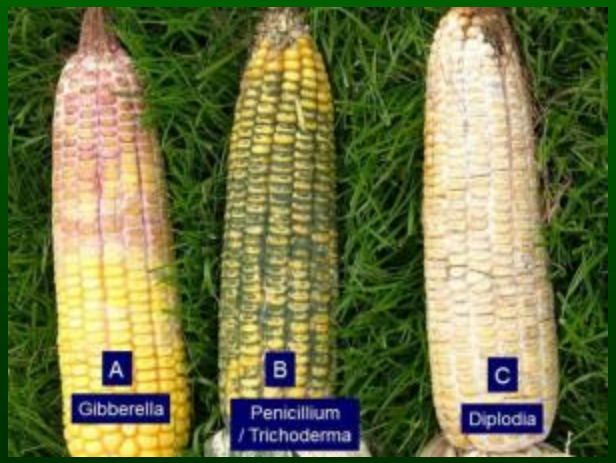
Precipitation (Rain)-Dalhart 2016 -Accuweather

August (2.85 inches)

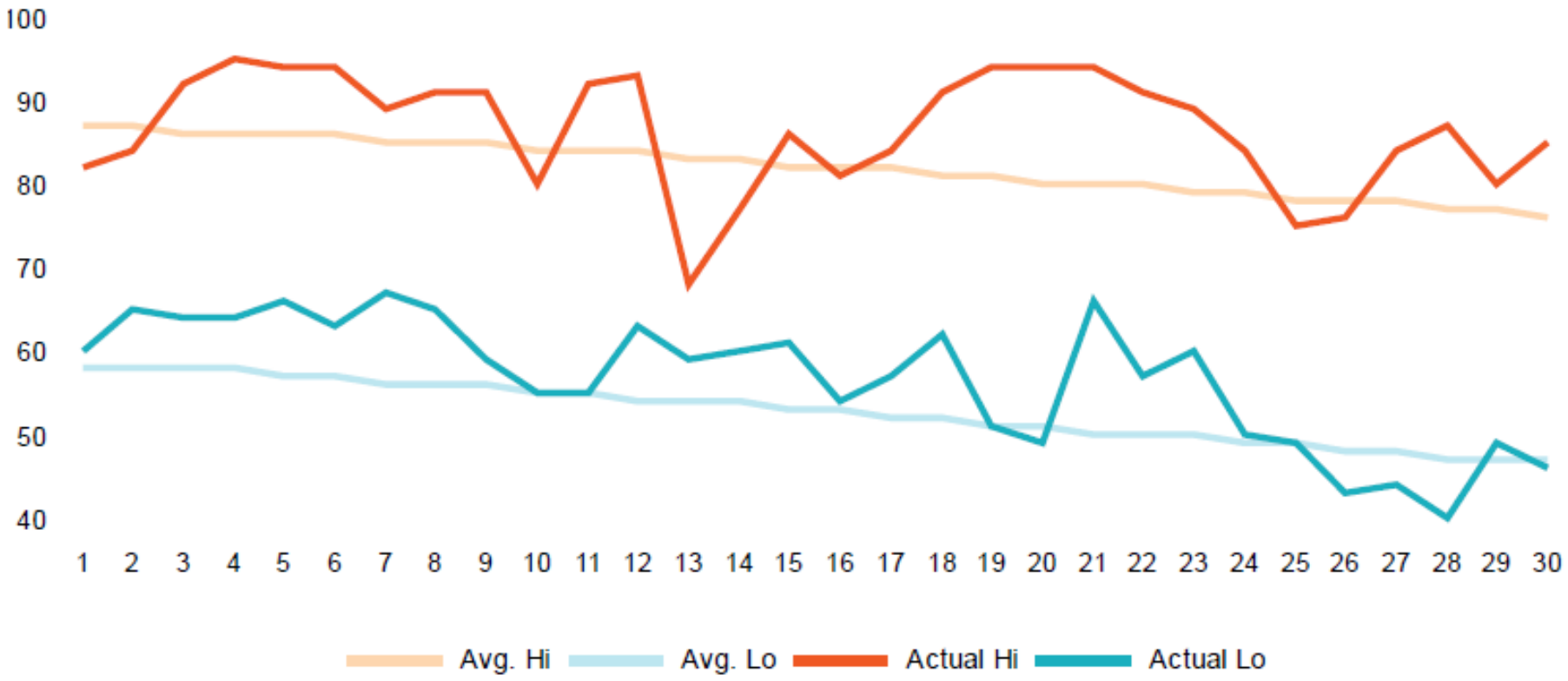
- 8/2 0.32
- 8/4 0.41
- 8/5 0.08
- 8/8 0.74
- 8/10 0.05
- 8/19 0.04
- 8/20 0.53
- 8/23 0.01
- 8/24 0.34
- 8/27 0.06
- 8/30 0.06
- 8/31 0.01

September (3.42 inches)

- 9/4 0.06
- **9/6 2.89**
- 9/15 0.08
- 9/17 **0.22**
- 9/21 0.02
- 9/23 0.15



Temperature Graph September 2016



THANK YOU !

For more information:

http://sickcrops.tamu.edu