TAR SPOT OF CORN:
ITS IMPACT IN INDIANA AND MANAGEMENT OPTIONS FOR THE FUTURE

Darcy Telenko

Assistant Professor/ Field Crop Extension Pathologist

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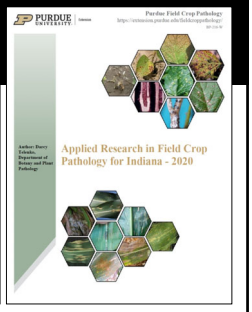
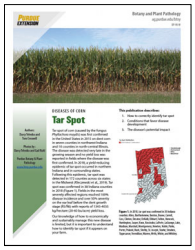
Resources for Indiana

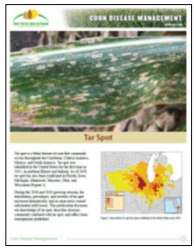


Follow on Twitter: @DTelenko

Purdue Field Crop Pathology Website
https://extension.purdue.edu/fieldcroppathology/

Applied Research in Field Crop Pathology for Indiana - **watch for 2021 in January**





Purdue Extension Publication – BP-90-W
https://www.extension.purdue.edu/extmedia/BP/BP-90-W.pdf

Crop Protection Network Publication
https://cropprotectionnetwork.org/

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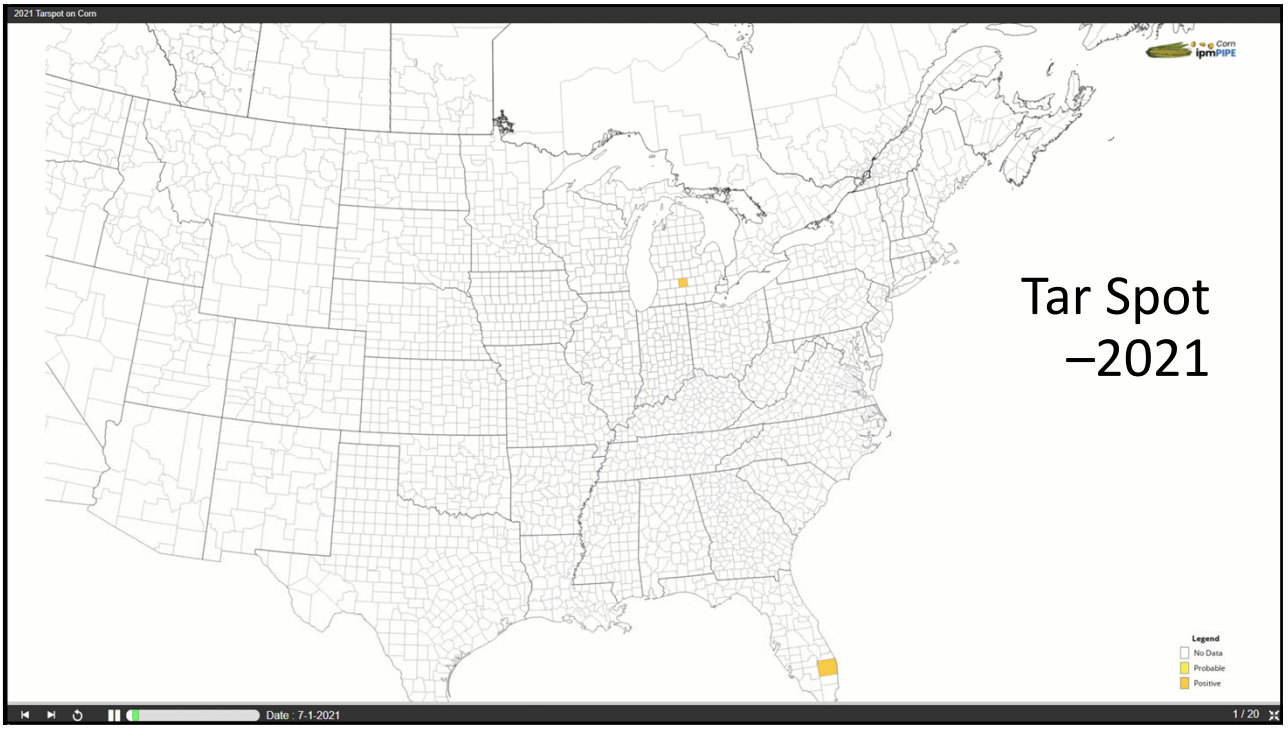
Tar spot of corn

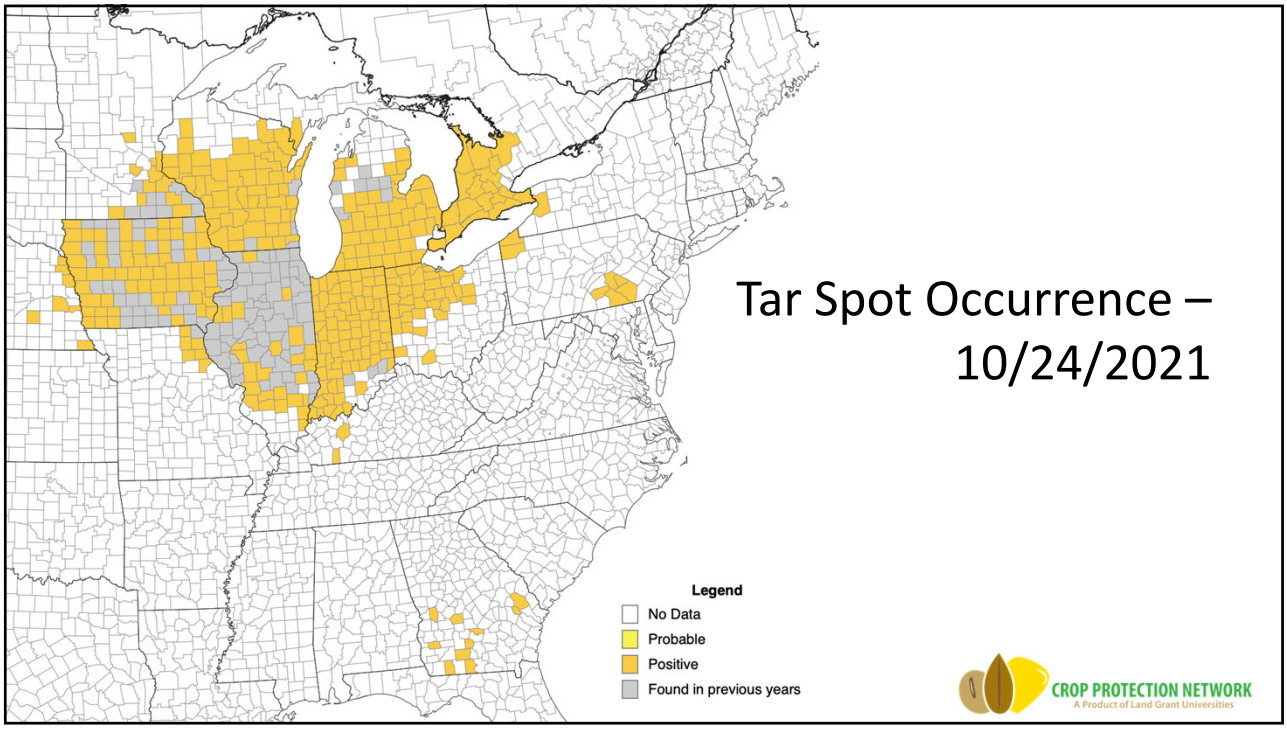
Tar Spot of Corn – Identification

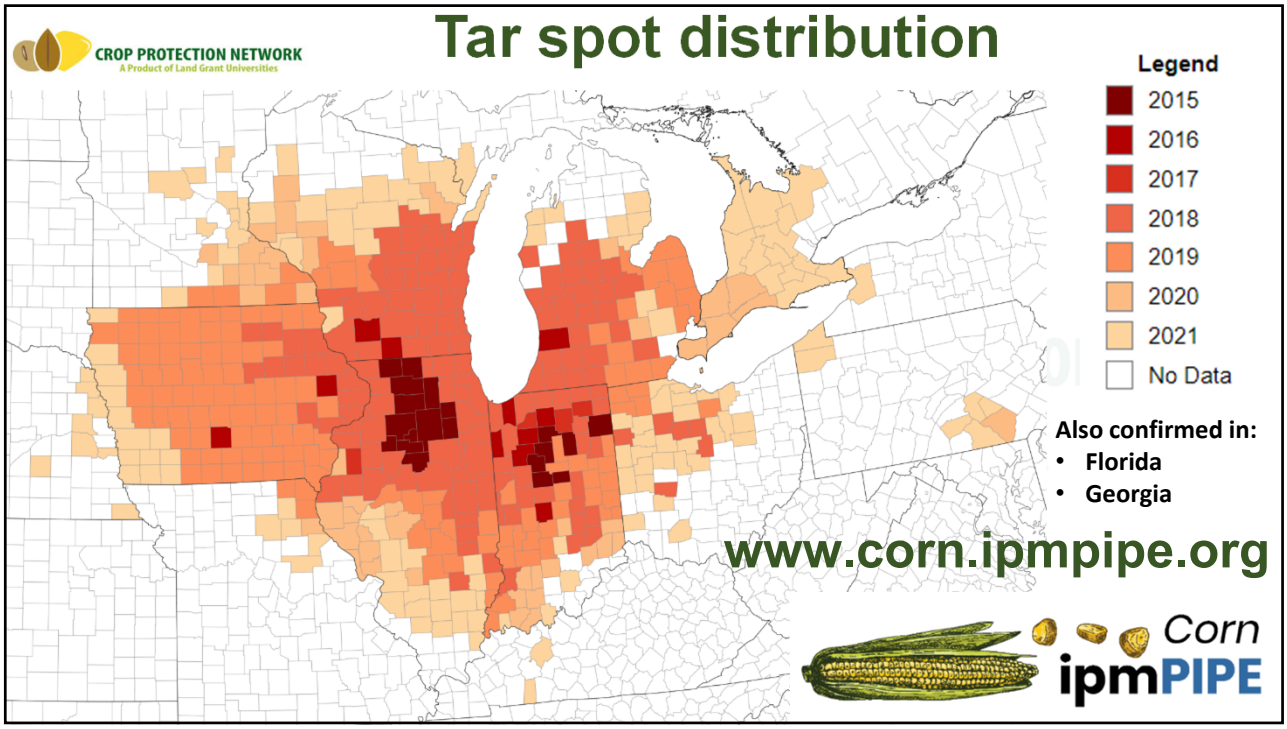
Causal agent: *Phyllachora maydis*

Tar Spot of Corn – Identification

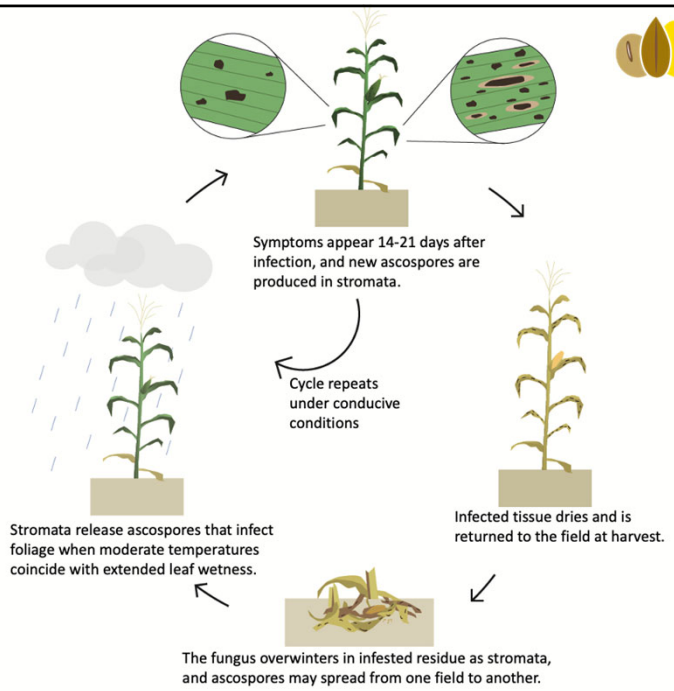
Causal agent: *Phyllachora maydis*




Tar Spot Occurrence – 10/24/2021
Legend
No Data
Probable
Positive
Found in previous years
CROP PROTECTION NETWORK
A Product of Land Grant Universities


Tar spot distribution
CROP PROTECTION NETWORK
A Product of Land Grant Universities
Legend
2015
2016
2017
2018
2019
2020
2021
No Data
Also confirmed in:
• Florida
• Georgia
www.corn.ipmpipe.org
Corn
ipmPIPE

Tar Spot Disease Cycle



The Genetics of *P. Maydis*

Current U.S. research efforts indicate:

- That there are endemic species of *Phyllachora* (mostly on grasses)
- Two Distinct populations of *P. maydis* in the U.S.
- Mexico population – closely related to isolates from Florida, Ohio, and Indiana
- Caribbean population – closely related to isolates from Iowa, Michigan, Illinois, Minnesota, and Wisconsin

Van Etten, K., Broders, K., Lolaski, S., Plewa, D., Duray, Z., Chilvers, M., Paul, P., Dalla Lana, F., Raid, R., Robertson, A., Malvick, D., Mueller, D., Smith, D., Telenko, D., Kleczewki, N. 2021. Diversity of Phyllachora species infecting maize and other grass species in the United States and Latin America. North Central APS Division Meeting. Abstract 19637.

Determining Tar Spot Risk in Indiana

Objectives

- Determine distribution of tar spot in Indiana
- What parts of the state are most at risk?
- What influences the annual epidemic?
- Can we use this information to monitor the disease and help prediction modeling in the future?

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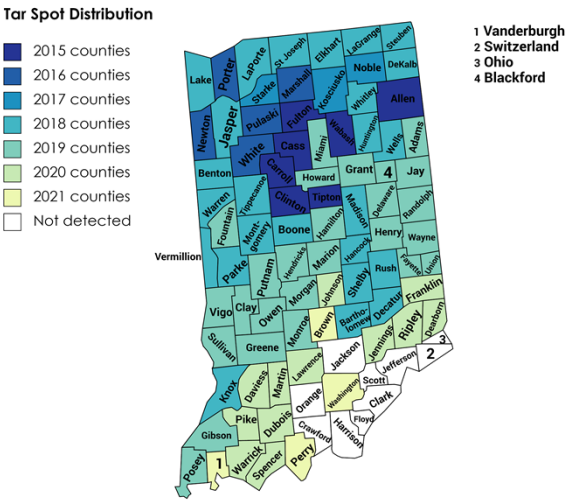
Yearly Distribution of Tar Spot in Indiana



2015 – 7 counties PPDL **FIRST REPORT US**
2016 – 5 new counties ples (13)
2017 – 3 new counties PPDL samples (16)
2018 - 25 new counties PPDL + survey (41)
2019 – 25 new counties PPDL + survey (66)
2020 – 12 new counties PPDL + survey (78)
2021 – 4 new counties PPDL + survey (82)

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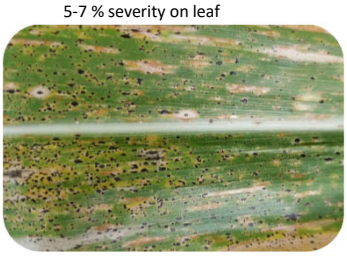
Range of Leaf Severity of Tar Spot

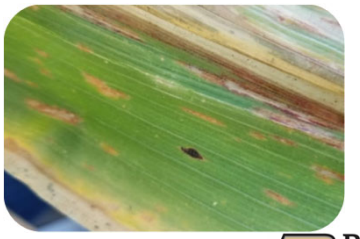
>25 % severity on leaf

5-7 % severity on leaf



1 % severity on leaf

<1 % severity on leaf



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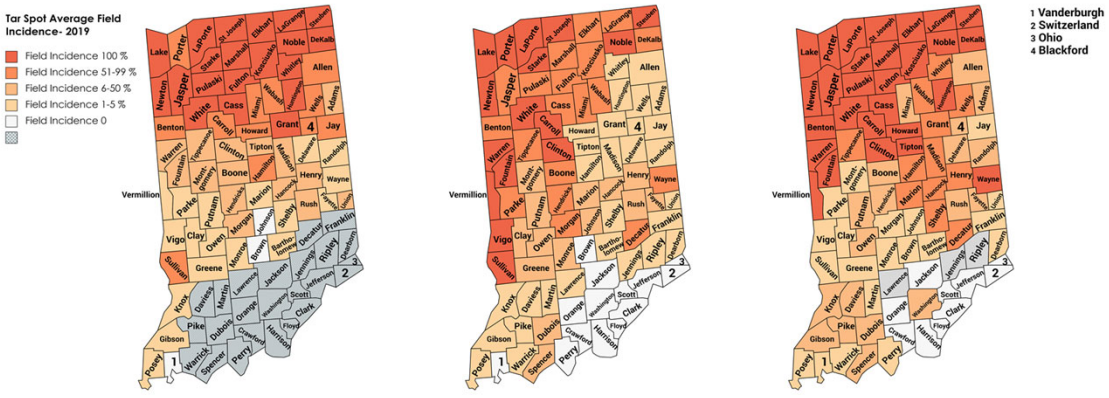
Survey of Tar Spot Average Field Incidence 2019-2021

2019 2020 2021



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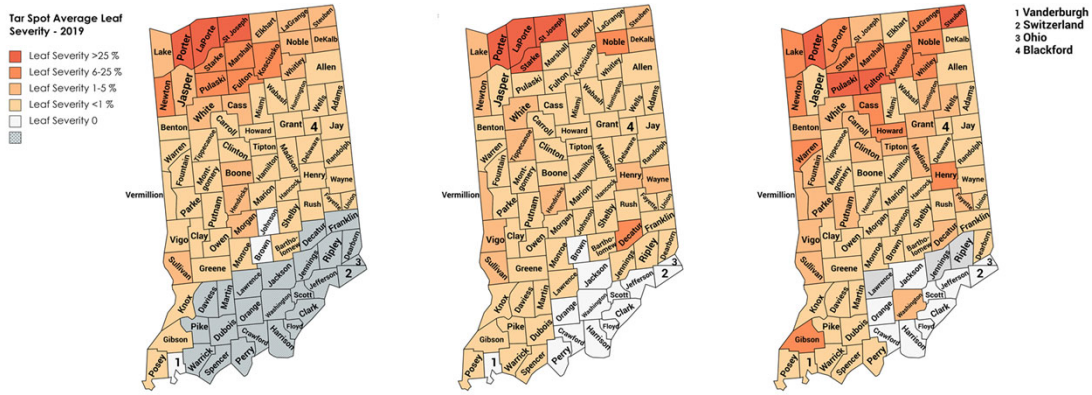
Survey of Tar Spot Average Leaf Severity 2019-2021

2019 2020 2021



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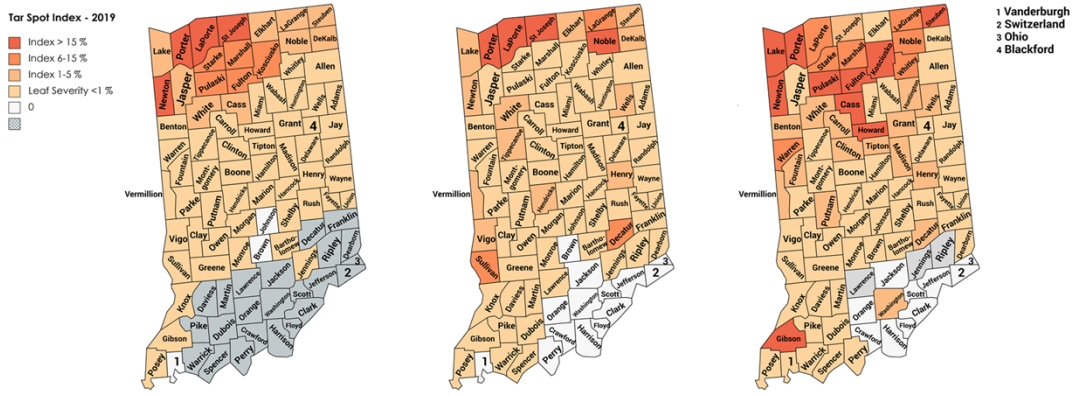
Survey of Tar Spot Index 2019-2021

2019 2020 2021



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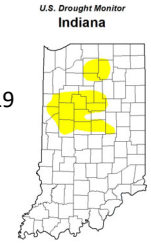
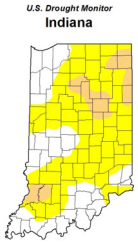
Drought Conditions 2019, 2020, and 2021

30 July 2019

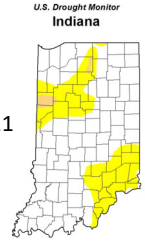


28 July 2020

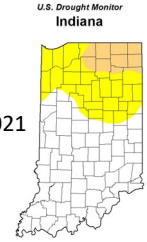


27 July 2021

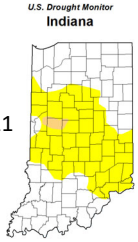
27 Aug 2021



25 Aug 2021



31 Aug 2021



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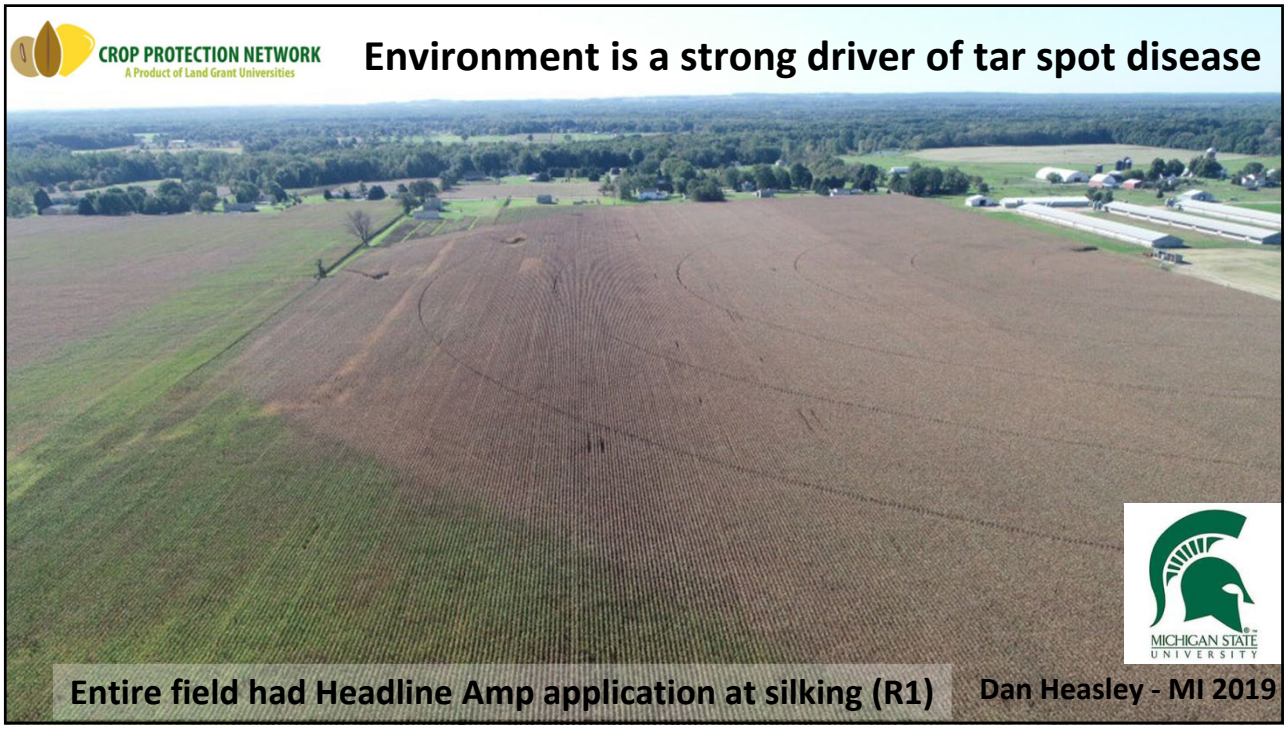
Environment is a strong driver of tar spot disease



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Entire field had Headline Amp application at silking (R1)

Dan Heasley - MI 2019

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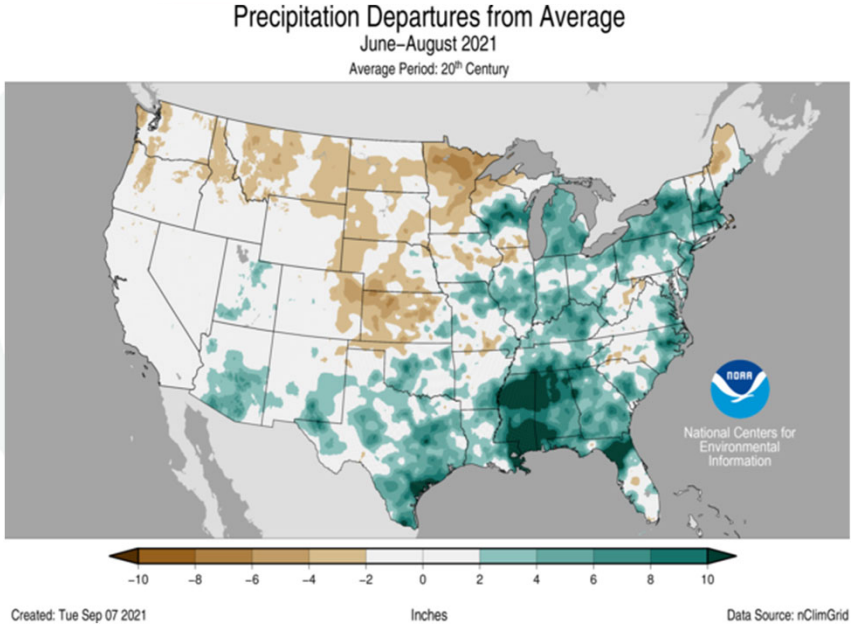
2021- Leaf wetness is a driving factor



Summary of Tar Spot Survey in Indiana

- Tar spot continues to spread in Indiana
  - 7 counties in 2015
  - 82 counties in 2021
- There is a range of severity in fields
  - Currently lower risk central and southern Indiana
  - High risk in northern Indiana
  - Pockets of disease in some areas, keep a close eye in the future
- Increasing inoculum for future epidemics
- Weather conditions will continue to play a signification role and influence annual risk

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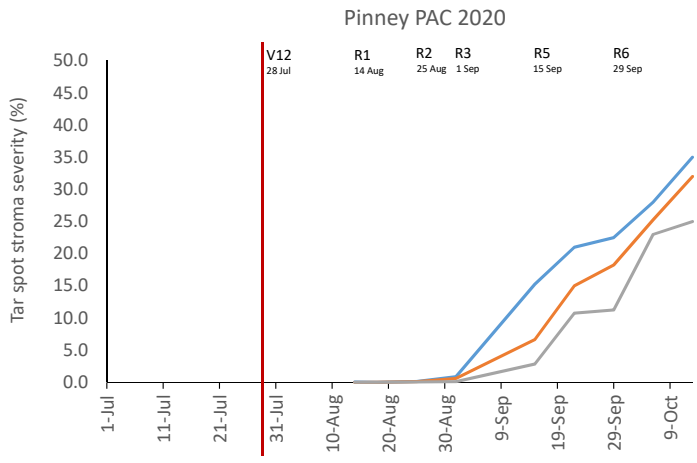
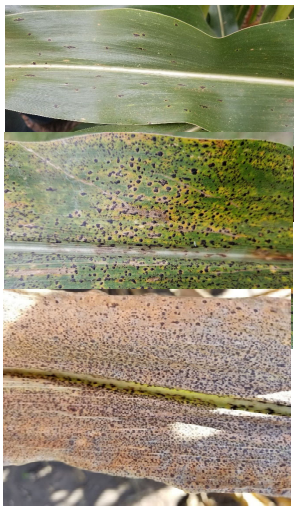
Management

Tar Spot Development in Non-Treated Canopy, Indiana 2020



28 July - tar spot first detected in plots at PPAC

Trial COR20-03
Location: PPAC
Hybrid: 'W2585SSRIB'



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Hybrid resistance/susceptibility

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MICHIGAN STATE UNIVERSITY

Image courtesy: Dan Heasley, MI

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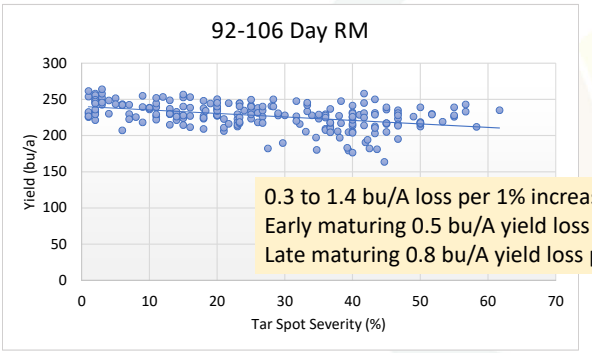
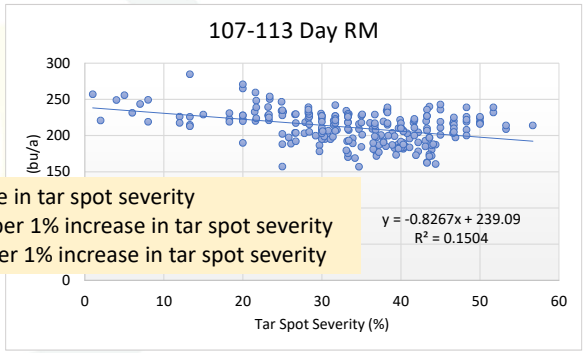
Impact of Tar Spot on Corn Hybrid Yield





0.3 to 1.4 bu/A loss per 1% increase in tar spot severity
Early maturing 0.5 bu/A yield loss per 1% increase in tar spot severity
Late maturing 0.8 bu/A yield loss per 1% increase in tar spot severity

*Data from Wisconsin, Michigan, Illinois, and Indiana - 2018

Telenko, D. E. P., Chilvers, M. I., Kleczewski, N., Smith, D. L., Byrne, A. M., Devillez, P., Diallo, T., Higgins, R., Joss, D., Lauer, J., Muller, B., Singh, M. P., Widdicombe, W. D., and Williams, L.A. 2019. How tar spot of corn impacted hybrid yields during the 2018 Midwest epidemic. Crop Protection Network. doi.org/10.31274/cpn-20190729-002

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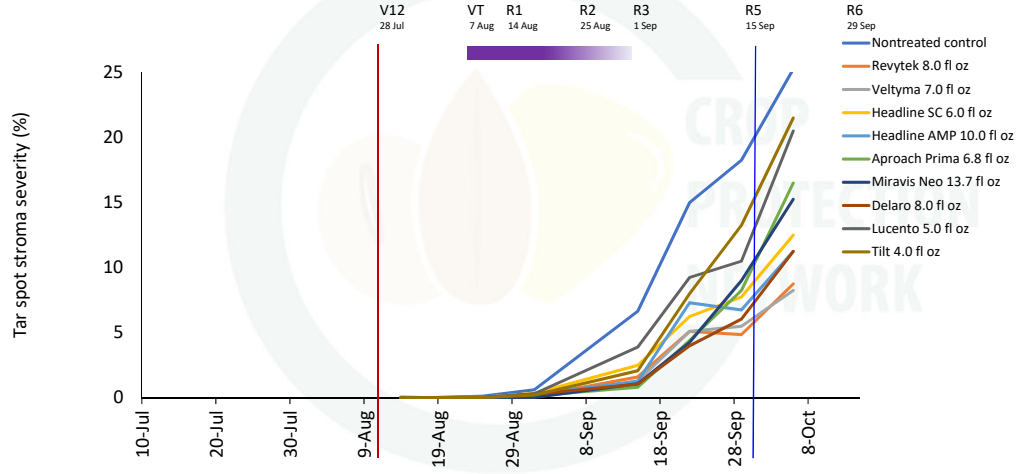
Fungicide Field Trials

Uniform Fungicide Trial for Tar Spot Disease Progress Indiana 2020



Trial COR20-03
Location: PPAC
Hybrid: 'W2585SSRIB'
Fungicide applied: 7 Aug VT/R1

28 July - tar spot first detected

Rapid development of tar spot in non-treated plots in Indiana 2019. Image on left taken 21 September and the same plot (right) 13 days later on 4 October

Source: Telenko et al. (2021). Fungicide efficacy on tar spot and yield of corn in the Midwestern United States. Plant Health Progress. *In press.*

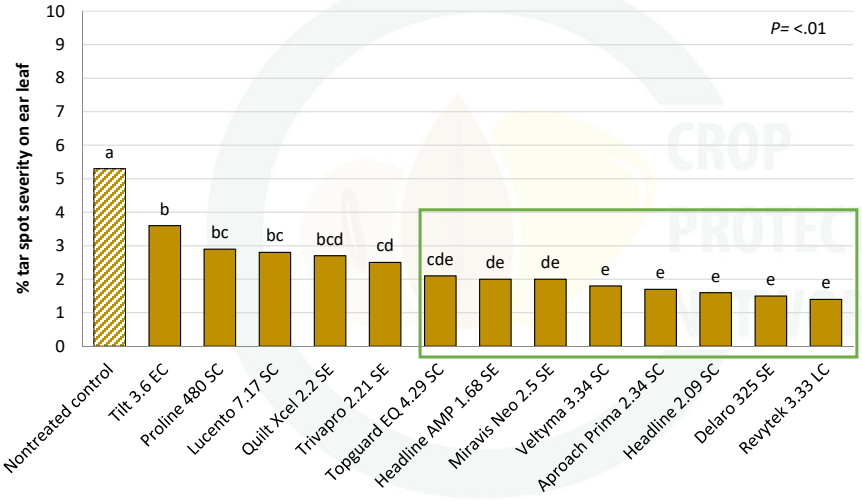
Fungicide Products Evaluated for Efficacy

Trade name®	Active ingredient (%)	Rate/A	FRAC Group
Aproach Prima 2.34SC	cyproconazole (7.17%) + picoxystrobin (17.94%)	6.8 fl oz	3+11
Delaro 325SC	prothioconazole (16.0%) + trifloxystrobin (13.7%)	8.0 fl oz	3+11
Headline 2.09SC	pyraclostrobin (23.6%)	6.0 fl oz	11
Headline AMP 1.68SC	pyraclostrobin (13.6%) + metconazole (5.1%)	10.0 fl oz	11+3
Lucento 4.17SC	flutrifol (19.3%) + bixafen (15.55%)	5.0 fl oz	3+7
Miravis Neo 2.5SE	pydiflumetofen (7.0%) + azoxystrobin (9.3%) + propiconazole (11.6%)	13.7 fl oz	7+11+3
Proline 480SC	prothioconazole (41.0%)	5.7 fl oz	3
Quilt Xcel 2.2SE	azoxystrobin (13.5%) + propiconazole (11.7%)	14.0 fl oz	11+3
Revytek 3.33LC	mefentrifluconazole (11.61%) + pyraclostrobin (15.49%) + fluxapyroxad (7.4%)	8.0 fl oz	3+11+7
Topgard EQ 4.29SC	azoxystrobin (25.30%) + flutrifol (18.63%)	7.0 fl oz	3+11
Tilt 3.6EC	propiconazole (41.8%)	4.0 fl oz	3
Trivapro 2.21SE	benzovindiflupyr (2.9%) + azoxystrobin (10.5%) + propiconazole (11.9%)	13.7 fl oz	7+1+3
Veltyma 3.24S	mefentrifluconazole (17.6%) + pyraclostrobin (17.6%)	7.0 fl oz	3+11

*FRAC group – 3=Sterol biosynthesis inhibitor: DMI fungicides; 7=Inhibitor of respiration in complex II. SDH: SDHI or carboxamide fungicides; 11=inhibitor of respiration in complex III at QoI: QoI or strobilurins.

Source: Telenko et al. (2021). Fungicide efficacy on tar spot and yield of corn in the Midwestern United States. Plant Health Progress. *In press.*

Uniform Fungicide Trial on Tar Spot – Disease Severity



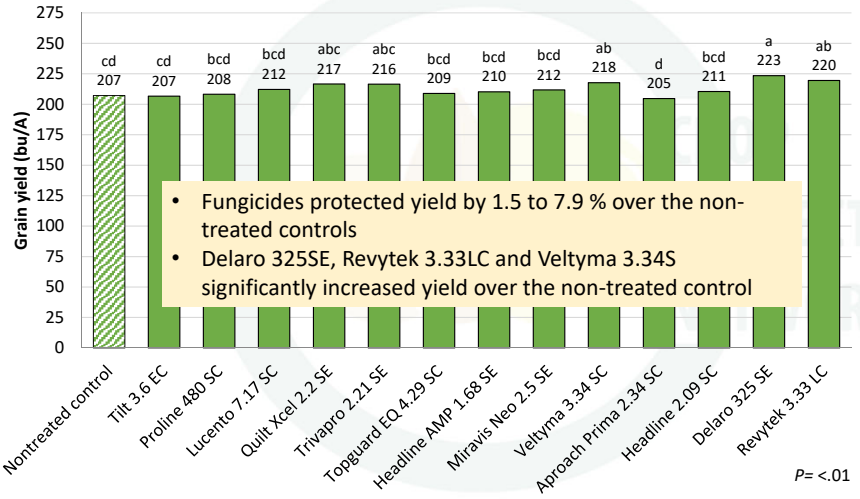
2019 and 2020 trials conducted in Illinois Indiana Michigan and Wisconsin (8 environments)

Range of tar spot in trials 1.6 to 23.3%

[y] Tar spot severity was rated by visually assessing the percentage of the symptomatic leaf area on the ear leaf on five plants per plot at the dent growth stage (R5).
[z] Values are least squares means. Values with different letters are significantly different based on least square means test (α=0.05).

Source: Telenko et al. (2021). Fungicide efficacy on tar spot and yield of corn in the Midwestern United States. Plant Health Progress. *In press.*

Uniform Fungicide Trial on Tar Spot – Yield



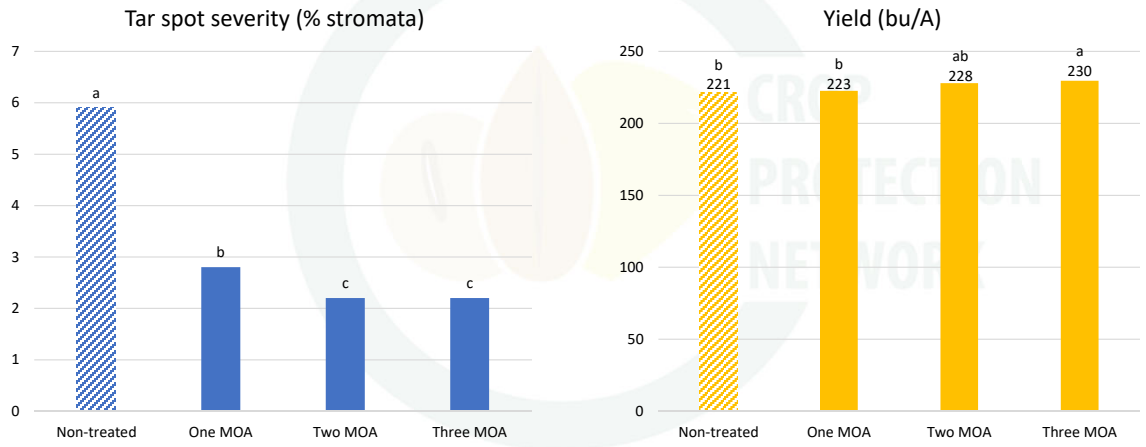
- Fungicides protected yield by 1.5 to 7.9 % over the non-treated controls
- Delaro 325SE, Revytek 3.33LC and Veltyma 3.34S significantly increased yield over the non-treated control

2019 and 2020 trials conducted in Illinois, Indiana, Michigan, and Wisconsin (8 environments)

Values are least squares means. Values with different letters are significantly different based on least square means test (α=0.05).

Source: Telenko et al. (2021). Fungicide efficacy on tar spot and yield of corn in the Midwestern United States. Plant Health Progress. *In press.*

Effect of Mode of Action (MOA) on Tar Spot Severity and Grain Yield



2019 and 2020 trials conducted in Illinois, Indiana, Michigan, and Wisconsin (8 environments)

Source: Telenko et al. (2021). Fungicide efficacy on tar spot and yield of corn in the Midwestern United States. Plant Health Progress. *In press.*

Summary

- Tar spot severity ranged from 1.6 to 23.3% in the trials
- All fungicides significantly reduce tar spot compared to non-treated controls (means of eight trials).
- Fungicides protected yield by 1.5 to 7.9 % over the non-treated controls
- Delaro 325SE, Revytek 3.33LC and Veltyma 3.34S significantly increased yield over the non-treated control
- Products that had two or three MOAs decreased tar spot severity over not treating and products with one MOA
- Three MOAs significantly increased yield over not treating with a fungicide or using a single MOA group

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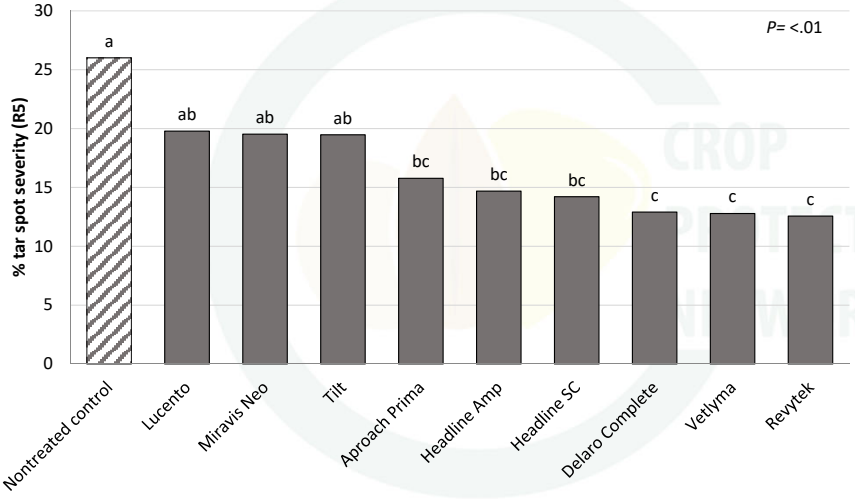
Fungicide Products Evaluated for Efficacy 2021

Trade name®	Active ingredient (%)	Rate/A	FRAC Group
Aproach Prima 2.34SC	cyproconazole (7.17%) + picoxystrobin (17.94%)	6.8 fl oz	3+11
Delaro Complete 3.83 SC	prothioconazole (14.9%) + trifloxystrobin (13.1%) + floupyram (10.9%)	8.0 fl oz	3+11+7
Headline 2.09SC	pyraclostrobin (23.6%)	6.0 fl oz	11
Headline AMP 1.68SC	pyraclostrobin (13.6%) + metconazole (5.1%)	10.0 fl oz	11+3
Lucento 4.17SC	flutrifol (19.3%) + bixafen (15.55%)	5.0 fl oz	3+7
Miravis Neo 2.5SE	pydiflumetofen (7.0%) + azoxystrobin (9.3%) + propiconazole (11.6%)	13.7 fl oz	7+11+3
Revytek 3.33LC	mefentrifluconazole (11.61%) + pyraclostrobin (15.49%) + fluxapyroxad (7.4%)	8.0 fl oz	3+11+7
Tilt 3.6EC	propiconazole (41.8%)	4.0 fl oz	3
Veltyma 3.24S	mefentrifluconazole (17.6%) + pyraclostrobin (17.6%)	7.0 fl oz	3+11

*FRAC group – 3=Sterol biosynthesis inhibitor: DMI fungicides; 7=Inhibitor of respiration in complex II. SDH: SDHI or carboxamide fungicides; 11=inhibitor of respiration in complex III at QoI: QoI or strobilurins.

Source: Telenko, Ames, Chilvers, Smith, and Tenuta (2021). Tar spot uniform fungicide trails 2021.

Uniform Fungicide Trial on Tar Spot – Disease Severity 2021

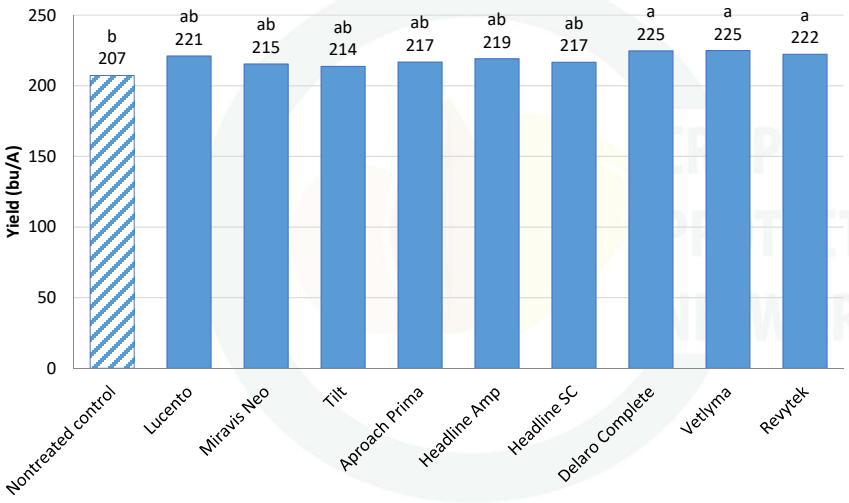


2021 trials conducted in Illinois, Indiana, Michigan, Wisconsin, and Ontario, CA (5 environments)

[y] Tar spot severity was rated by visually assessing the percentage of the symptomatic leaf area on the ear leaf at the dent growth stage (R5).
[z] Values are least squares means. Values with different letters are significantly different based on least square means test (α=0.05).

Source: Telenko, Ames, Chilvers, Smith, and Tenuta (2021). Tar spot uniform fungicide trails 2021.

Uniform Fungicide Trial on Tar Spot – Yield 2021



2021 trials conducted in Illinois, Indiana, Michigan, Wisconsin, and Ontario, CA (5 environments)

P= 0.004

[z] Values are least squares means. Values with different letters are significantly different based on least square means test (α=0.05).

Source: Telenko, Ames, Chilvers, Smith, and Tenuta (2021). Tar spot uniform fungicide trails 2021.

Fungicide Timing – Indiana 2019, 2020, 2021

Fungicide: Trivapro 13.7 fl oz/A

First detection of tar spot

2019
- V7 – 8 Jul
- V9 – 15 Jul **13 Jul**
- V10 – 19 Jul
- VT/R1 – 7 Aug
- R2 – 23 Aug
- V7 fb VT – 8 Jul, 7 Aug
- Tarspotter – no app

2020
- V8 – 14 Jul
- V10 – 20 Jul
- VT/R1 – 7 Aug **28 Jul**
- R2 – 21 Aug
- R3 – 2 Sep
- R4 – 11 Sep
- R5 – 23 Sep
- V8 fb VT – 14 Jul,7 Aug
- Tarspotter – no app

2021 **3 Jul**
- V8 – 23 Jul
- V12 – 2 Aug
- R1 – 6 Aug
- R2 – 20 Aug
- R3 – 30 Aug
- R4 – 10 Sep
- R5 – 16 Sep
- V8 fb R1 – 23 Jul, 6 Aug
- Tarspotter – 2 Aug

Trials COR19-05/COR20-05/COR21-03
Location: PPAC
Hybrid: 'W2585SSRIB'

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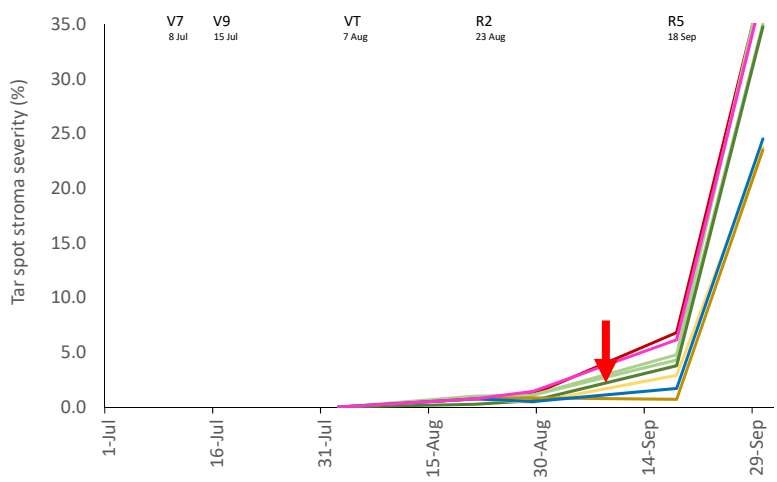
Fungicide Timing and Model Validation for Tar Spot in Corn – Disease Progress, Indiana 2019



Trial COR19-05
Location: PPAC
Hybrid: 'W2585SSRIB'
Fungicide: Trivapro 13.7 fl oz/A
13 Jul 2019 tar spot first detected

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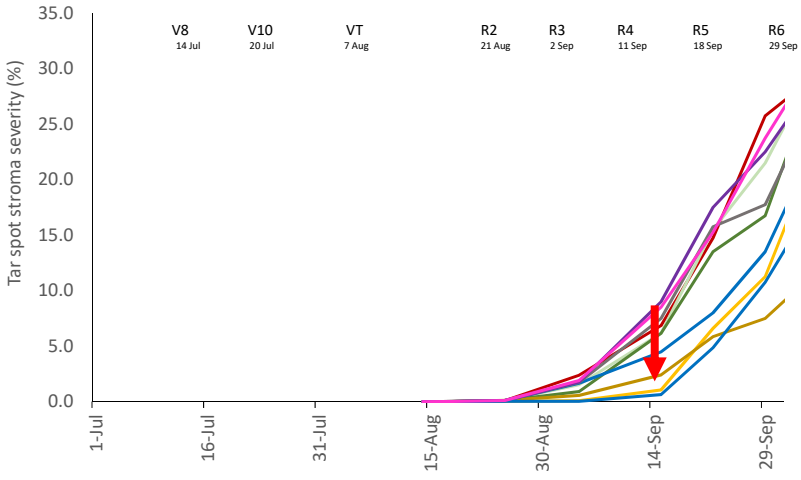
Fungicide Timing and Model Validation for Tar Spot in Corn – Disease Progress, Indiana 2020



Trial COR20-05
Location: PPAC
Hybrid: 'W2585SSRIB'
Fungicide: Trivapro 13.7 fl oz/A
28 July 2020 tar spot first detected

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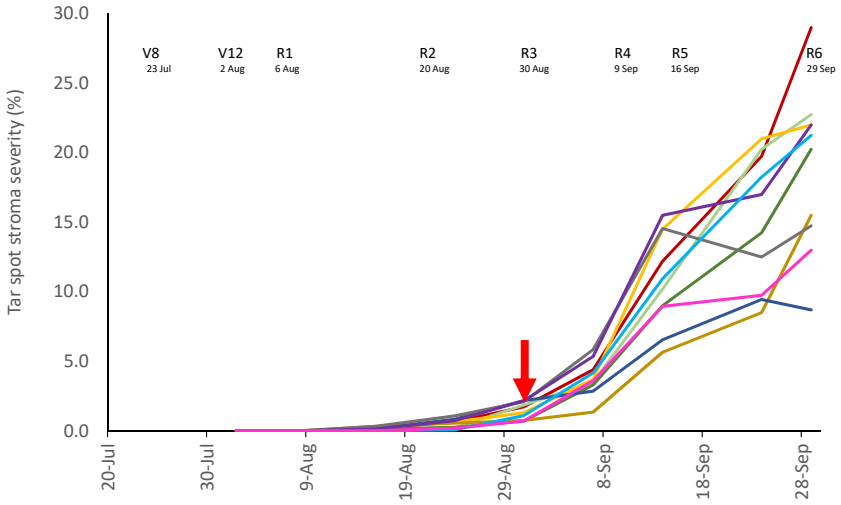
Fungicide Timing and Model Validation for Tar Spot in Corn – Disease Progress, Indiana 2021



Trial COR21-03
Location: PPAC
Hybrid: 'W2585SSRIB'
3 July 2021 tar spot first detected

Trivapro 13.7 fl oz/A
Note on R1 – 1.5 inches rain from popup storm after application

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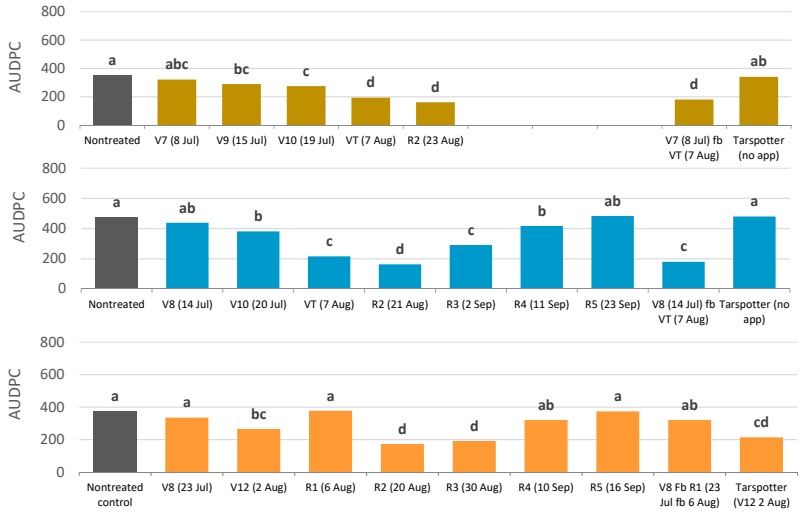
Fungicide Timing and Model Validation for Tar Spot in Corn – AUDPC on Ear Leaf in Indiana 2019, 2020 and 2021



2019

Trial COR20-05
Location: PPAC
Hybrid: 'W2585SSRIB'
Fungicide: Trivapro 13.7 fl oz/A
28 July 2020 tar spot first detected

2020

Trial COR20-05
Location: PPAC
Hybrid: 'W2585SSRIB'
Fungicide: Trivapro 13.7 fl oz/A
28 July 2020 tar spot first detected

2021

Trial COR21-03
Location: PPAC
Hybrid: 'W2585SSRIB'
3 July 2021 tar spot first detected

Note on R1 – 1.5 inches rain from popup storm after application in 2021

Trivapro 13.7 fl oz/A

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Fungicide Timing and Model Validation for Tar Spot in Corn – Yield in Indiana 2019, 2020 and 2021

2019
Trial COR20-05
Location: PPAC
Hybrid: 'W2585SSRIB'
Fungicide: Trivapro 13.7 fl oz/A
28 July 2020 tar spot first detected

2020
Trial COR20-05
Location: PPAC
Hybrid: 'W2585SSRIB'
Fungicide: Trivapro 13.7 fl oz/A
28 July 2020 tar spot first detected

2021
Trial COR21-03
Location: PPAC
Hybrid: 'W2585SSRIB'
3 July 2021 tar spot first detected

Note on R1 – 1.5 inches rain from popup storm after application in 2021

Trivapro 13.7 fl oz/A

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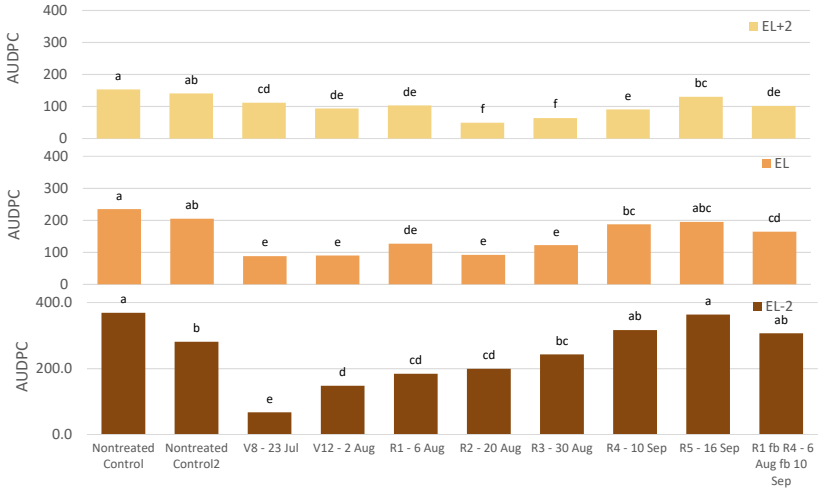
Evaluation of Veltyma Fungicide Programs for Tar Spot in Corn– *COR21-35*

Tar spot AUDPC



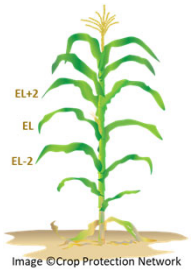


Image ©Crop Protection Network

Trial COR21-35
Location: PPAC
Hybrid: 'W2585SSRIB'
3 July 2021 tar spot first detected

Note on R1 – 1.5 inches rain from popup storm after application

Veltyma 7 fl oz/A

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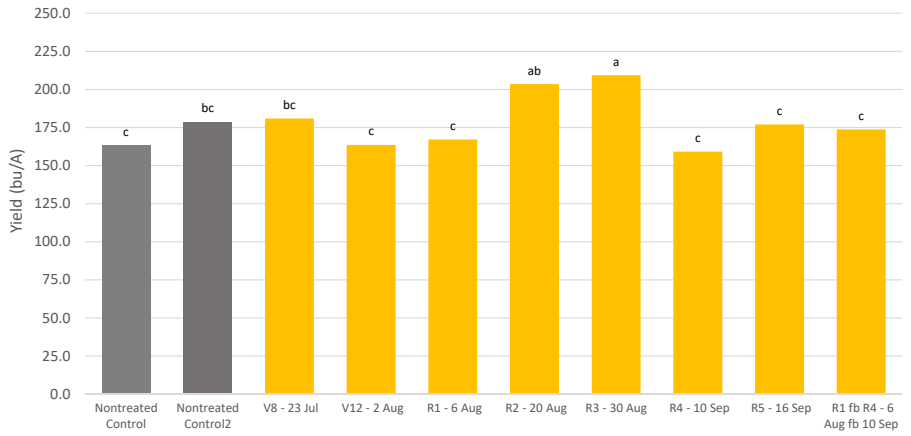
Evaluation of Veltyma Fungicide Programs for Tar Spot in Corn– *COR21-35*

Corn Yield



R2 + 32.5 bu
R3 + 38.3 bu

Trial COR21-35
Location: PPAC
Hybrid: 'W2585SSRIB'
3 July 2021 tar spot first detected

Note on R1 – 1.5 inches rain from popup storm after application

Veltyma 7 fl oz/A

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Fungicide Timing and Application for Tar Spot in Corn – *COR20-15* and *COR21-06*

Fungicide Products and Timings Evaluated

Trt	Treatment rate/A and timing	2020 Dates	2021 Dates
1	Nontreated control		
2	Veltyma 7 fl oz at 1st detection	8/5/2020 (early VT)	7/14/2021 (V6)
3	Veltyma 7 fl oz at V8	7/14/2020	7/23/2021
4	Veltyma 7 fl oz at VT	8/7/2020	8/6/2021
5	Veltyma 7 fl oz at R3	9/2/2020	8/27/2021
6	Veltyma 7 fl oz at 1st detection fb 3 WAT	8/5/2020 fb 8/27/2020	7/14/2021 fb 8/2/2021
7	Veltyma 7 fl oz at V8 fb 3 WAT	7/14/2020 fb 8/5/2020	7/23/2021 fb 8/12/2021
8	Veltyma 7 fl oz at VT fb 3 WAT	8/7/2020 fb 8/27/2020	8/6/2021 fb 8/27/2021
9	Veltyma 7 fl oz at R3 fb 3 WAT	9/2/2020 fb 9/23/2020	8/30/2021 fb 9/16/2021
10	Nontreated control		
11	Lucento 5 fl oz at 1st detection	8/5/2020 (early VT)	7/14/2021 (V6)
12	Lucento 5 fl oz at V8	7/14/2020	7/23/2021
13	Lucento 5 fl oz at VT	8/7/2020	8/6/2021
14	Lucento 5 fl oz at R3	9/2/2020	8/27/2021
15	Lucento 5 fl oz at 1st detection fb 3 WAT	8/5/2020 fb 8/27/2020	7/14/2021 fb 8/2/2021
16	Lucento 5 fl oz at V8 fb 3 WAT	7/14/2020 fb 8/5/2020	7/23/2021 fb 8/12/2021
17	Lucento 5 fl oz at VT fb 3 WAT	8/7/2020 fb 8/27/2020	8/6/2021 fb 8/27/2021
18	Lucento 5 fl oz at R3 fb 3 WAT	9/2/2020 fb 9/23/2020	8/30/2021 fb 9/16/2021

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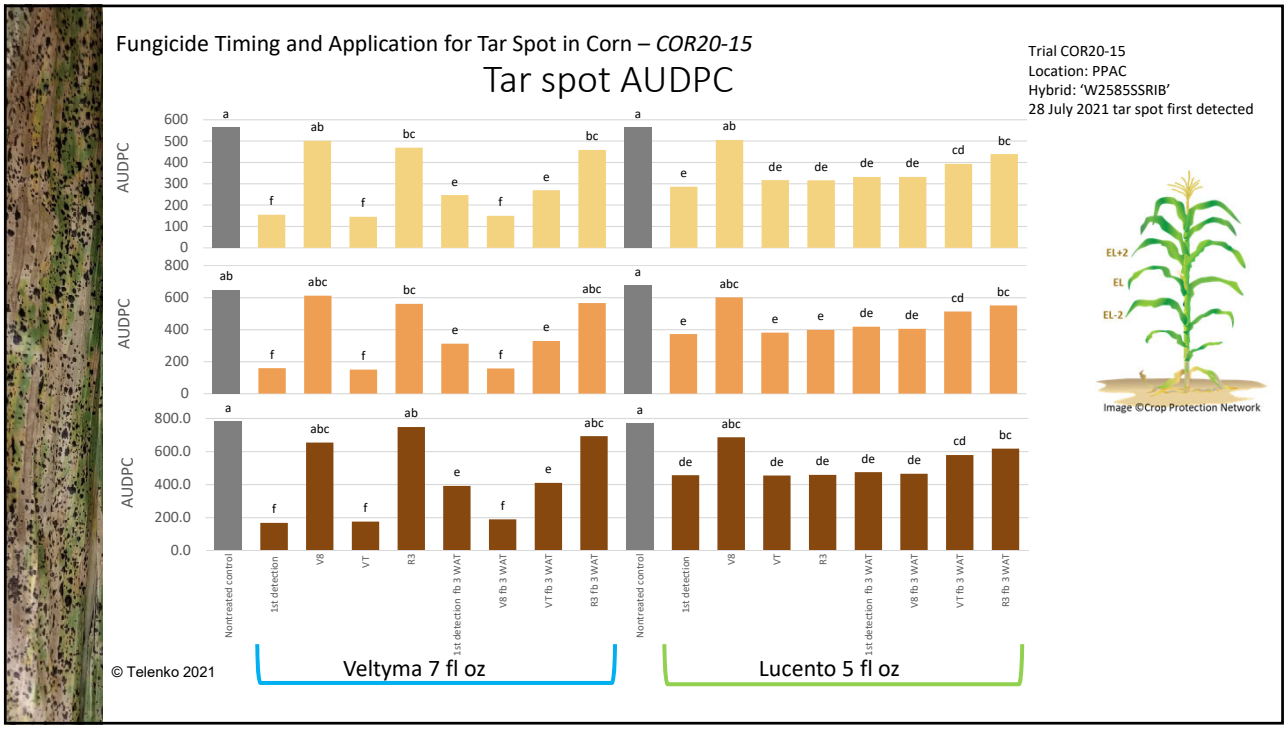
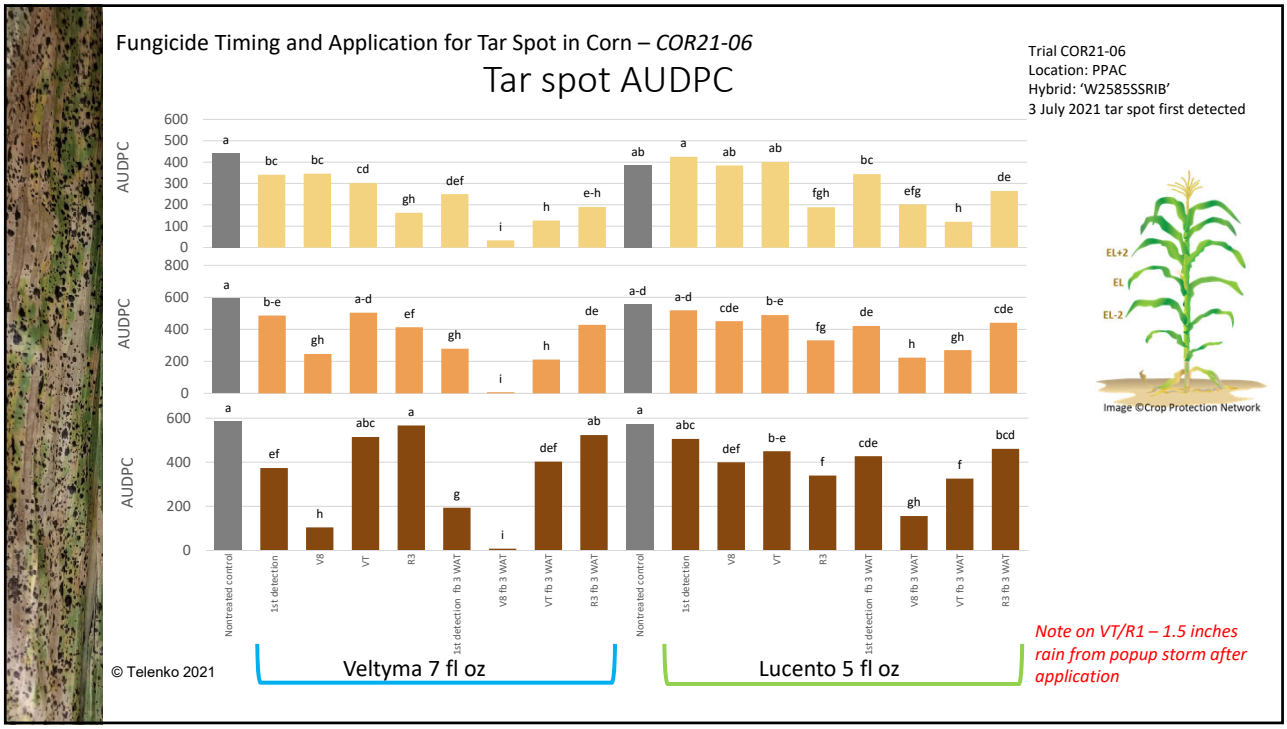

Fungicide Timing and Application for Tar Spot in Corn – COR20-15
Tar spot AUDPC
Trial COR20-15
Location: PPAC
Hybrid: 'W2585SSRIB'
28 July 2021 tar spot first detected
AUDPC
Nontreated control
1st detection
V8
VT
R3
1st detection fb 3 WAT
V8 fb 3 WAT
VT fb 3 WAT
R3 fb 3 WAT
EL+2
EL
EL-2
Image ©Crop Protection Network
© Telenko 2021
Veltyma 7 fl oz
Lucento 5 fl oz


Fungicide Timing and Application for Tar Spot in Corn – COR21-06
Tar spot AUDPC
Trial COR21-06
Location: PPAC
Hybrid: 'W2585SSRIB'
3 July 2021 tar spot first detected
AUDPC
Nontreated control
1st detection
V8
VT
R3
1st detection fb 3 WAT
V8 fb 3 WAT
VT fb 3 WAT
R3 fb 3 WAT
EL+2
EL
EL-2
Image ©Crop Protection Network
© Telenko 2021
Veltyma 7 fl oz
Lucento 5 fl oz
Note on VT/R1 – 1.5 inches rain from popup storm after application

Fungicide Timing and Application for Tar Spot in Corn – *COR21-06*

Nontreated control **vs** Veltyma 7 fl oz/A at V8 fb 3 WAT
30 Sep at R6 growth stage

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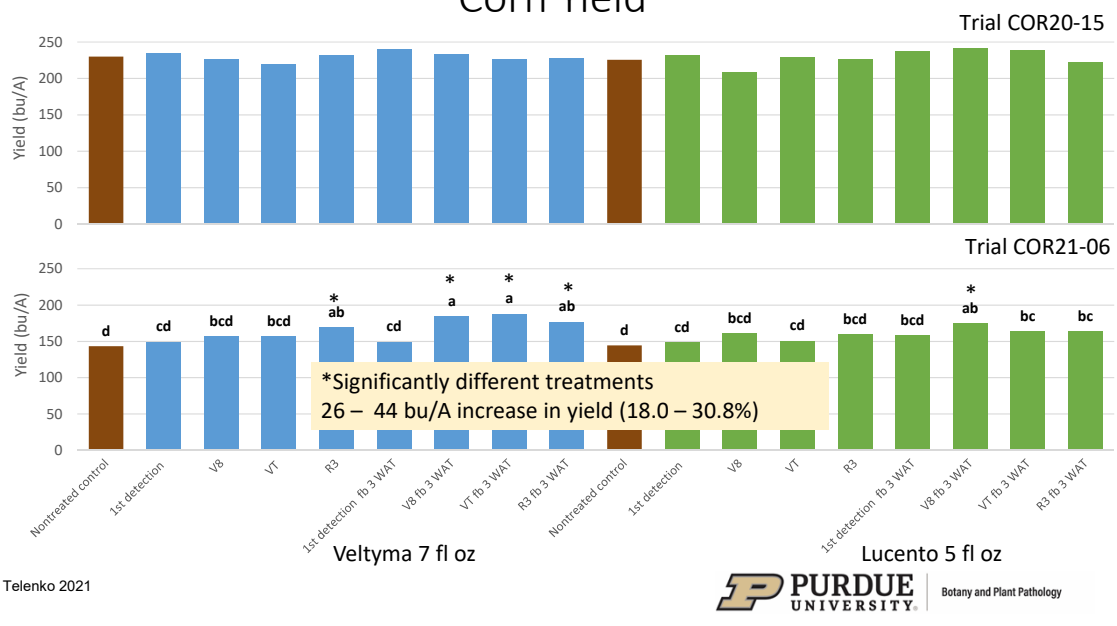
Fungicide Timing and Application for Tar Spot in Corn – *COR20-15, COR21-06*



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Fungicide Program Evaluation for Tar Spot – COR20-14

Trt	Treatment*	Rate/A	Timing
1	Nontreated control		
2	Miravis Neo 2.5 SC	13.7 fl oz	V12
3	Miravis Neo 2.5 SC	13.7 fl oz	VT/R1
4	Miravis Neo 2.5 SC	13.7 fl oz	R2
5	Miravis Neo 2.5 SC	13.7 fl oz	R3
6	Trivapro 2.21 SE	13.7 fl oz	VT/R1
7	Trivapro 2.21 SE	13.7 fl oz	R2
8	Aproach Prima 2.34 SC	6.8 fl oz	VT/R1
9	Aproach 6 fl oz @ V7 fb Aproach Prima 2.34 SC 6.8 fl oz @VT/R1	6.0 fl oz fb 6.8 fl oz	V7 fb VT/R1
10	Fortix NXT	6 fl oz	VT/R1
11	Zolera ODX	5 fl oz	VT/R1
12	Dexter Xcel	48 fl oz	VT/R1
13	Zolera FX	5 fl oz	VT/R1
14	Fortix NXT	6 fl oz	V7
15	Fortix 3.22 SC	5 fl oz	V7
16	Headline AMP 1.68 SC	10 fl oz	VT/R1
17	Nontreated control		

*All treatments applied at VT/R1, R2, and R3 contained a non-ionic surfactant (Preference) at a rate of 0.25% v/v.

Trial COR20-14
Location: PPAC
Hybrid: 'W2585SSRIB'
28 July 2021 tar spot first detected

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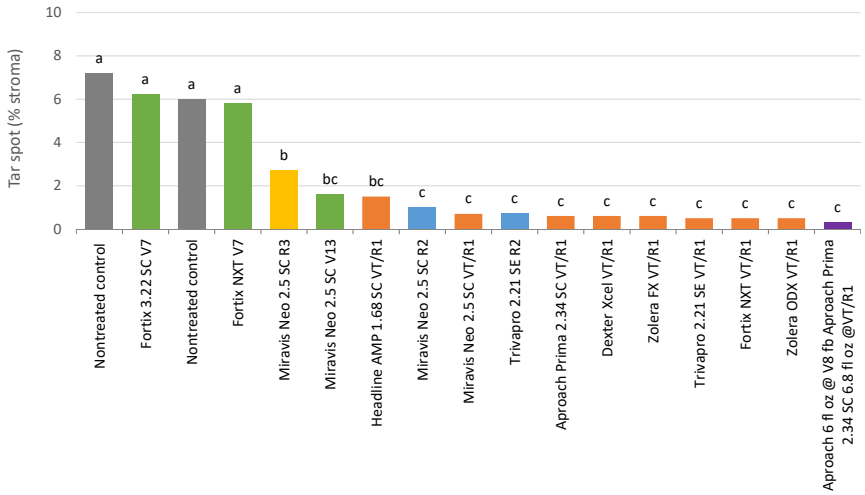
Fungicide Program Evaluation for Tar Spot – COR20-14
Tar spot stroma severity R5



Trial COR20-14
Location: PPAC
Hybrid: 'W2585SSRIB'
28 July 2021 tar spot first detected
*All treatments applied at R1, R2, and R3 contained a non-ionic surfactant (Preference) at a rate of 0.25% v/v.

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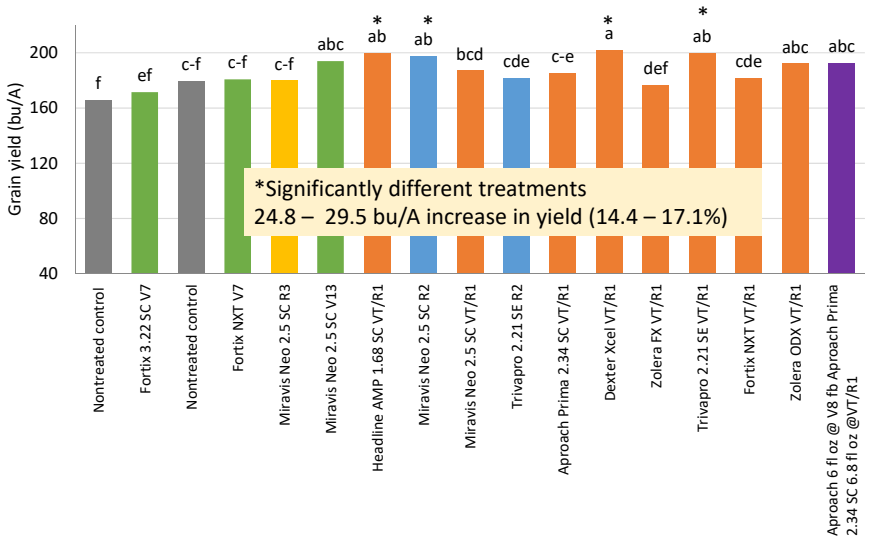
Fungicide Program Evaluation for Tar Spot – COR20-14
Yield (bu/A)



Trial COR20-14
Location: PPAC
Hybrid: 'W2585SSRIB'
28 July 2021 tar spot first detected
*All treatments applied at R1, R2, and R3 contained a non-ionic surfactant (Preference) at a rate of 0.25% v/v.

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Fungicide Program Evaluation for Tar Spot – COR21-15

Trt	Treatment*
1	Nontreated Control
2	Miravis Neo 13.7 fl oz/A at V12 (NO NIS)
3	Miravis Neo 13.7 fl oz/A + NIS at R1
4	Miravis Neo 13.7 fl oz/A at V12 (NO NIS) + Miravis Neo 13.7 fl oz + NIS at R3
5	Trivapro 13.7 fl oz/A + NIS at R1
6	Delaro Complete 8.0 fl oz/A + NIS at R1
7	Veltyma 7.0 fl oz/A + NIS at R1
8	Aproach Prima 6.8 fl oz/A + NIS at R1
9	Brixen 15.0 fl oz/A + NIS at R1
10	Brixen 13.0 fl oz/A + NIS at R1
11	Brixen 10.0 fl oz/A + NIS at R1
12	Zolera ODX 5 fl oz/A + NIS at R1
13	Vacciplant SL 14 fl oz/A + NIS at R1
14	Zolera ODX 5 fl oz/A + Vacciplant SL 14 fl oz/A + NIS at R1
15	Zolera ODX 5 fl oz/A + NIS at R2
16	Vacciplant SL 14 fl oz/A + NIS at R2
17	Zolera ODX 5 fl oz/A + Vacciplant SL 14 fl oz/A + NIS at R2
18	Veltyma 7.0 fl oz/A + NIS at R2
19	Delaro Complete 8.0 fl oz/A + NIS at R2
20	Nontreated Control

*All treatments applied at R1, R2, and R3 contained a non-ionic surfactant (Preference) at a rate of 0.25% v/v.

Trial COR21-15
Location: PPAC
Hybrid: 'W2585SSRIB'
3 July 2021 tar spot first detected

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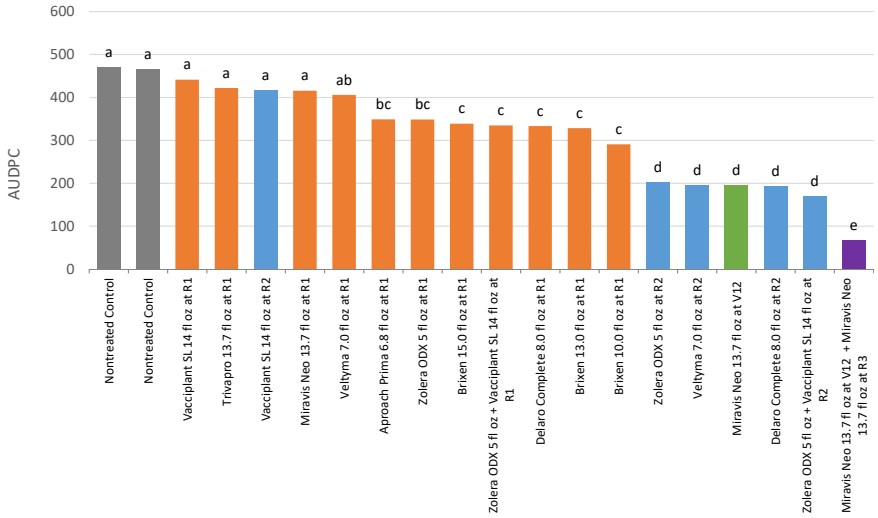
Fungicide Program Evaluation for Tar Spot – COR21-15 AUDPC



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Trial COR21-15
Location: PPAC
Hybrid: 'W2585SSRIB'
3 July 2021 tar spot first detected
*All treatments applied at R1, R2, and R3 contained a non-ionic surfactant (Preference) at a rate of 0.25% v/v.

Note on R1 – 1.5 inches rain from popup storm after application

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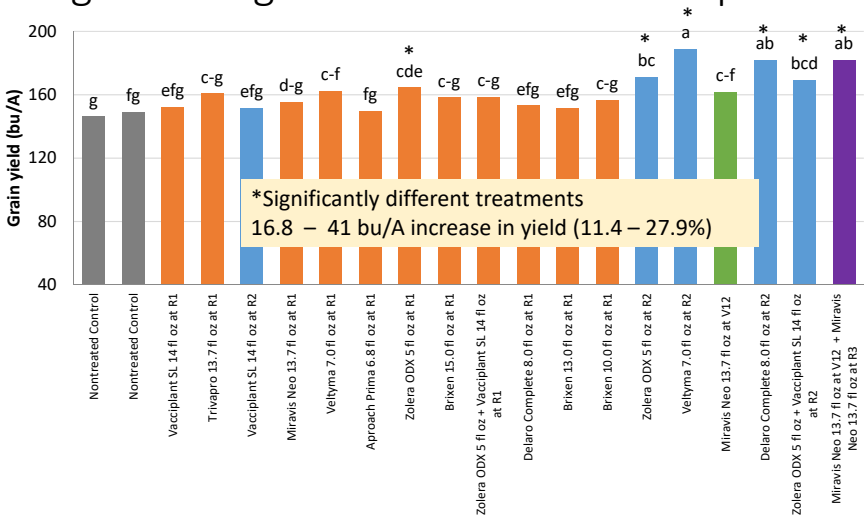
Fungicide Program Evaluation for Tar Spot – COR21-15



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Trial COR21-15
Location: PPAC
Hybrid: 'W2585SSRIB'
3 July 2021 tar spot first detected
*All treatments applied at R1, R2, and R3 contained a non-ionic surfactant (Preference) at a rate of 0.25% v/v.

Note on R1 – 1.5 inches rain from popup storm after application

Values are least squares means. Values with different letters are significantly different based on least square means test (α=0.05).

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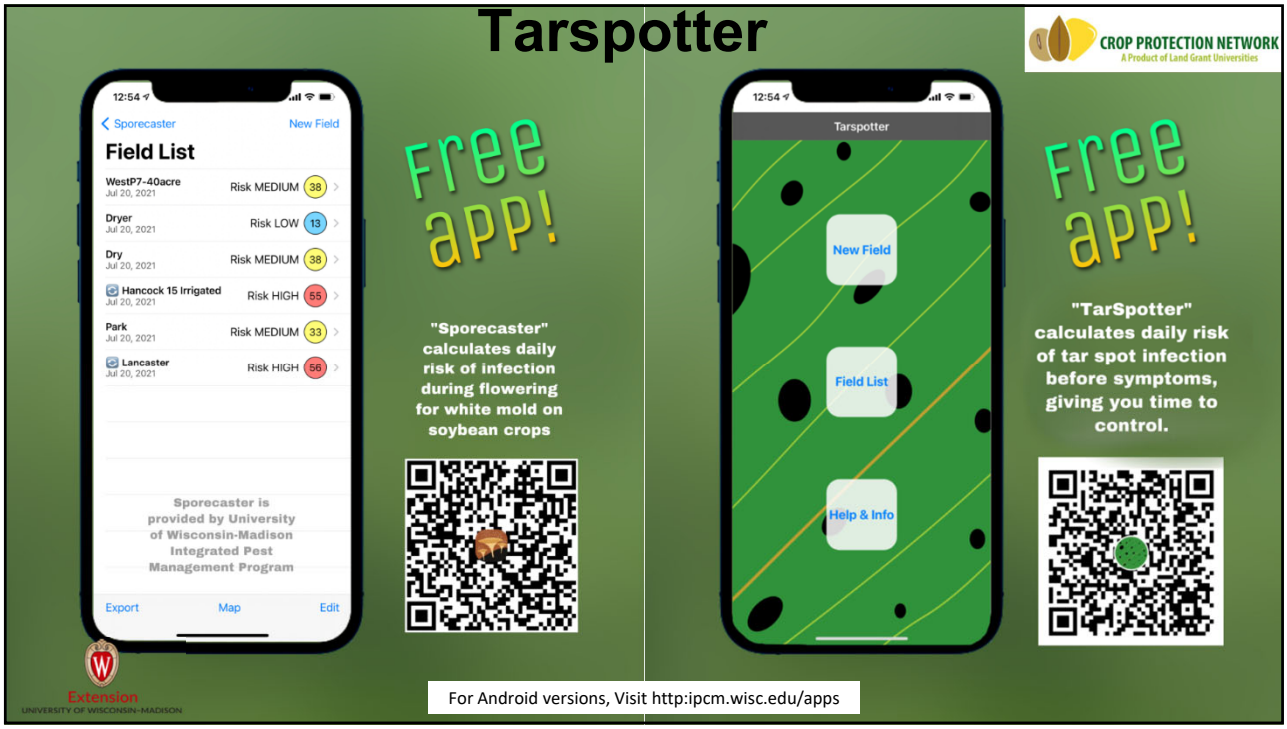
Disease Prediction is Key - Tarspotter

- **Development and validation work supported by Wisconsin Corn Promotion Board and National Corn Growers Association**
- Sporecaster set the framework to build on for deploying models for other diseases
- Platform is easy to use and flexible – Uses Logistic regression models (think probabilities!)
- Simply retrain the models using the biologically appropriate weather variables and moving averages
- Validate, retrain, validate – this is an iterative process (Machine Learning)

Extension
UNIVERSITY OF WISCONSIN-MADISON



The Tar Spot Take Home

- **Tar spot will continue to be an issue in Indiana**
  - Severity level will be a function of the hybrid, weather, and when epidemic initiates earlier vs. later in the season (episodic disease like white mold or Fusarium head blight)
  - The 2021 epidemic was problematic, because tar spot started in some fields before tasseling
  - Fungus driven by weather – a wet July in 2021 compared to 2019 and 2020.
  - Varying levels of tar spot occur across state due to weather
- **The tar spot fungus can overwinter in the upper Midwest**
  - High inoculum levels
  - Weather key (irrigation management)
  - Rotation may help a bit, not a sole solution
  - Tillage may help reduce or delay onset of disease (reducing residue) – inoculum can travel long distances, so tillage won't solve it all
- **Some hybrids are more resistant than others**
  - Resistance not tied to brand – Every hybrid stands on its own
  - Strong hybrid resistance can be overcome by a favorable disease environment (Manage irrigation!)
- **Fungicide application can reduce tar spot severity**
  - Product important (QoI + DMI or QoI + DMI + SDHI)
  - **Timing very important**
  - Application needs to occur close to the onset of the epidemic
  - Number of applications and optimal timing are going to vary by year (**Think Disease Triangle!**)
  - Tarspotter isn't perfect, but a valuable tool to help make the decision, and optimize, fungicide applications
  - If just spraying once and not interested in prediction, VT-R2 has been most consistent timing
  - Understand your farm – what disease are most of concern

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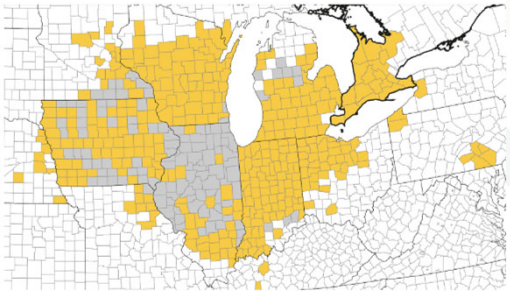
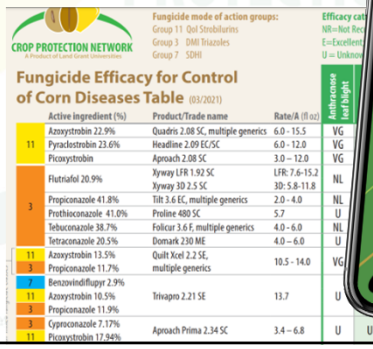
What can you do?

- **Assess risk – is it endemic in your area? – Scout!!!**
- **Talk to your seed salesperson about hybrid resistance**
- **If applying fungicides be sure to leave check strips**
- **Help monitor areas not confirmed – diagnostic clinic**
- **Don't forget about other diseases - new and established**





What else are we doing?

- Screening hybrids
- Screening inbreds
- Spore trapping
- Residue/tillage studies
- Genomics
- Host-pathogen interaction

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Additional Tar Spot Research

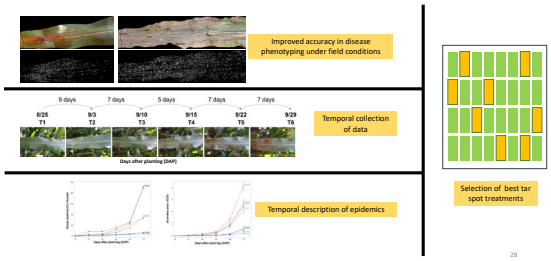
INDIANA CORN Marketing Council

PURDUE AGRICULTURE AgSEED

Cruz and Telenko

- Contour-based detection and quantification of tar spot stromata using RGB imagery
- Development of Stromata Contour Detection Algorithm (SCDA)

Potential applications of SCDA algorithm



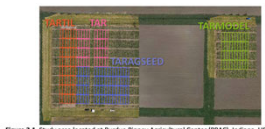


Figure 3.1. Study area located at Purdue Pinney Agricultural Center (PPAC), Indiana, USA. Unmanned aircraft systems (UAS) images of research plots (TAR, TARTIL, TARAGSEED, TARMODEL) were overlaid on Google Map satellite image (Google, n.d.).

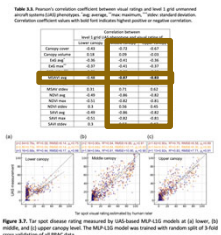


Figure 3.7. Tar spot disease rating measured by UAS-based MLP-LSG models at (a) lower, (b) middle, and (c) upper canopy level. The MLP-LSG model was trained with random split of 3-fold cross validation of all PPAC data.

- Tar spot disease quantification using unmanned aircraft systems (UAS) data

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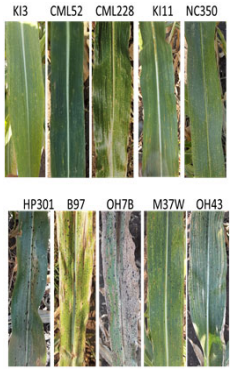
Tar spot research at USDA in collaboration with Purdue University

Genetics of resistance



Scored 300 progeny lines in two crosses for tar spot

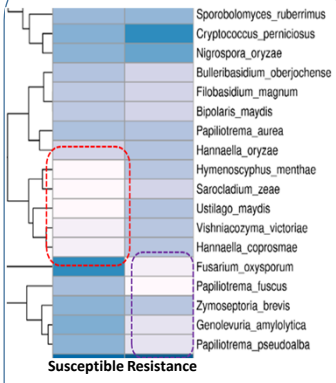
↓

Identify closely linked markers that breeders can use to select for resistance

↓

Genetic analysis to map resistance genes

Corn microbiome



Analyzed bacteria and fungi on resistant versus susceptible lines

↓

Identified many species that were different

↓

Hope to isolate, identify and test species of bacteria and fungi that might be antagonistic against the tar spot pathogen

Host-pathogen interactions

Developing an improved genome sequence

↓

Identified likely host-interacting genes from the existing genome and testing for effects in plants

↓

Hope to design improved resistance in the future

Basic biology of the pathogen

Have hired a technician in collaboration with Purdue University

↓

Will work on methods for culturing the fungus and for inoculating plants in the field and greenhouse

↓

Also working on automated methods for scoring the disease

Tar spot yield loss survey

We would like your help:

- Document yield loss to tar spot
- Examine production practices that may impact tar spot

- Any questions? – please ask Dr. Martin Chilvers, at chilvers@msu.edu

MICHIGAN STATE UNIVERSITY

ONLINE SURVEY CONSENT FORM

You are being asked to participate in a research study. The purpose of the study is **to gather farmer and industry representative estimates on yield losses and changes in management decisions due to tar spot**. You will be asked to **complete a short 10-minute survey asking about your experiences**. Your participation is voluntary. You can skip any question you do not wish to answer or withdraw at any time**.** You must be 18 or older to participate. If you have any questions please contact **Dr. Martin Chilvers**, at **chilvers@msu.edu**. You indicate that you voluntarily agree to participate in this research study by submitting the survey.

Acknowledgements

CropProtectionNetwork.org

Partners

CropProtectionNetwork.org

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Many Thanks

Darcy Telenko, PhD.

Phone: (765) 496-5168

Email: dtelenko@purdue.edu

Follow me on Twitter: @DTelenko

https://extension.purdue.edu/fieldcroppathology

Many Collaborators

- Tar spot working group
- Corn and Soybean Disease Working Groups

Research and Extension Support

- FFAR-Roar
- National Corn Board
- Indiana Corn Marketing Council
- Indiana Soybean Alliance
- Purdue University
- North Central Soybean Research Program
- USWBSI –NFO
- USDA- ARS - AGPMT
- USDA- Hatch project #IND00162952
- USDA- NIFA
- Industry: AMVAC, BASF, Bayer CropScience, Certis, Corteva, FMC, Gowan, Oro Agri, Pioneer, Sipcam, Syngenta, UPD NA Inc., Valent

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