Integrated Management of Vomitoxin in Corn Silage and the Fate of Vomitoxin During Ensiling

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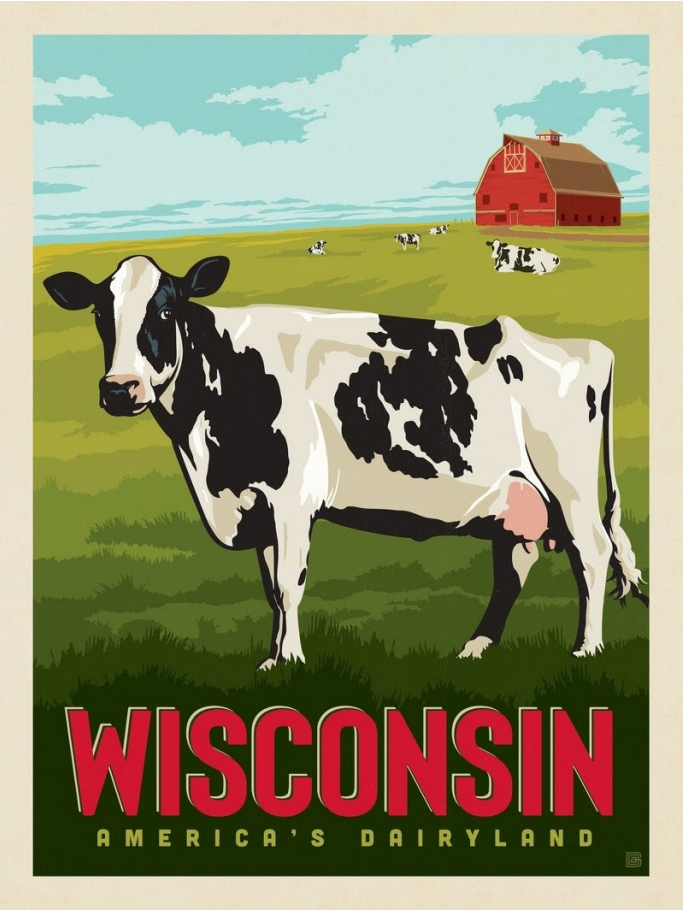
US Dairy Industry

- Wisconsin is the 2nd leading producer of milk (~32.1 billion lbs / 14.5 billion kg) in 2024 [USDA, 2024]

- Wisconsin is the leading producer of cheese and many other milk products.

- Corn silage constitutes close to half of the daily diet of dairy cows.



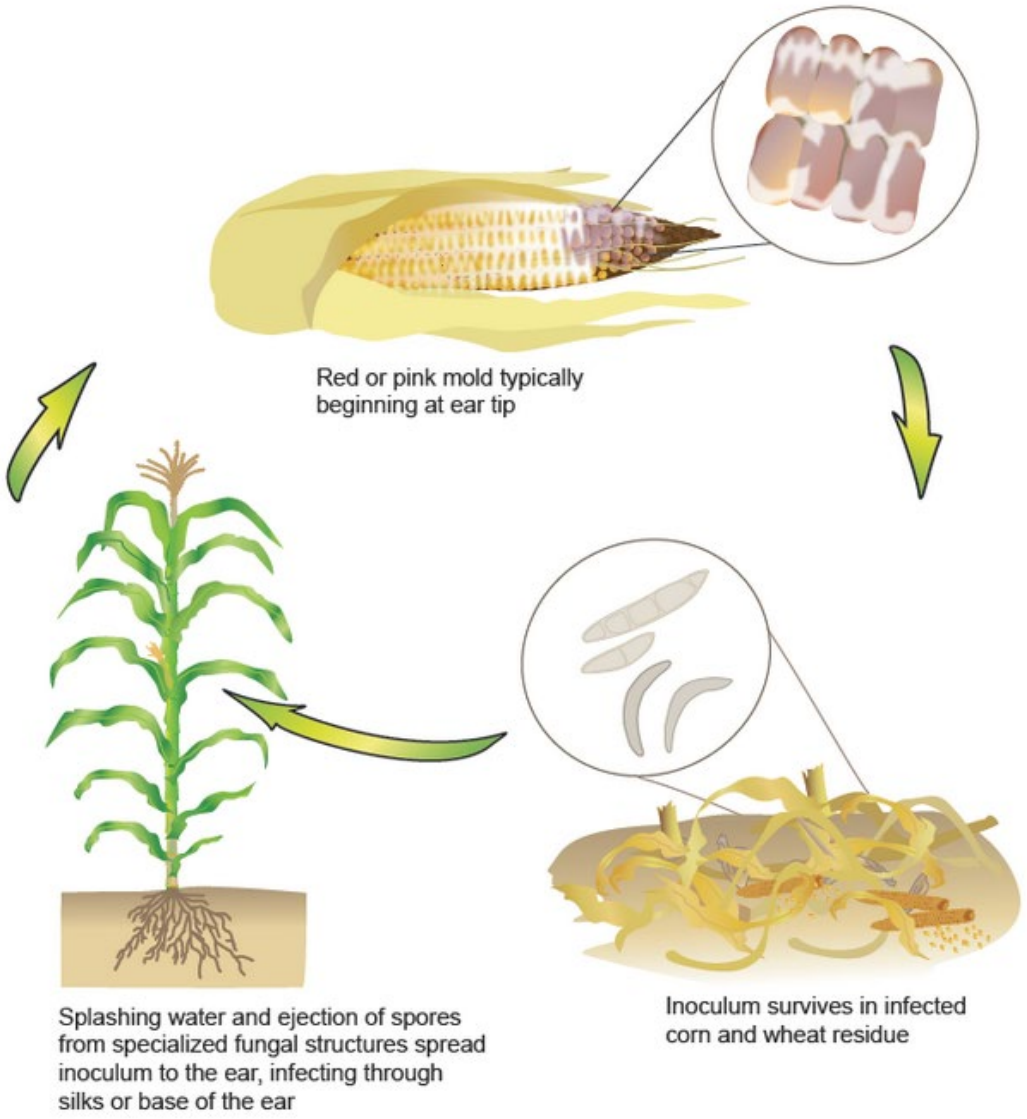
Corn silage and production

Gibberella diseases

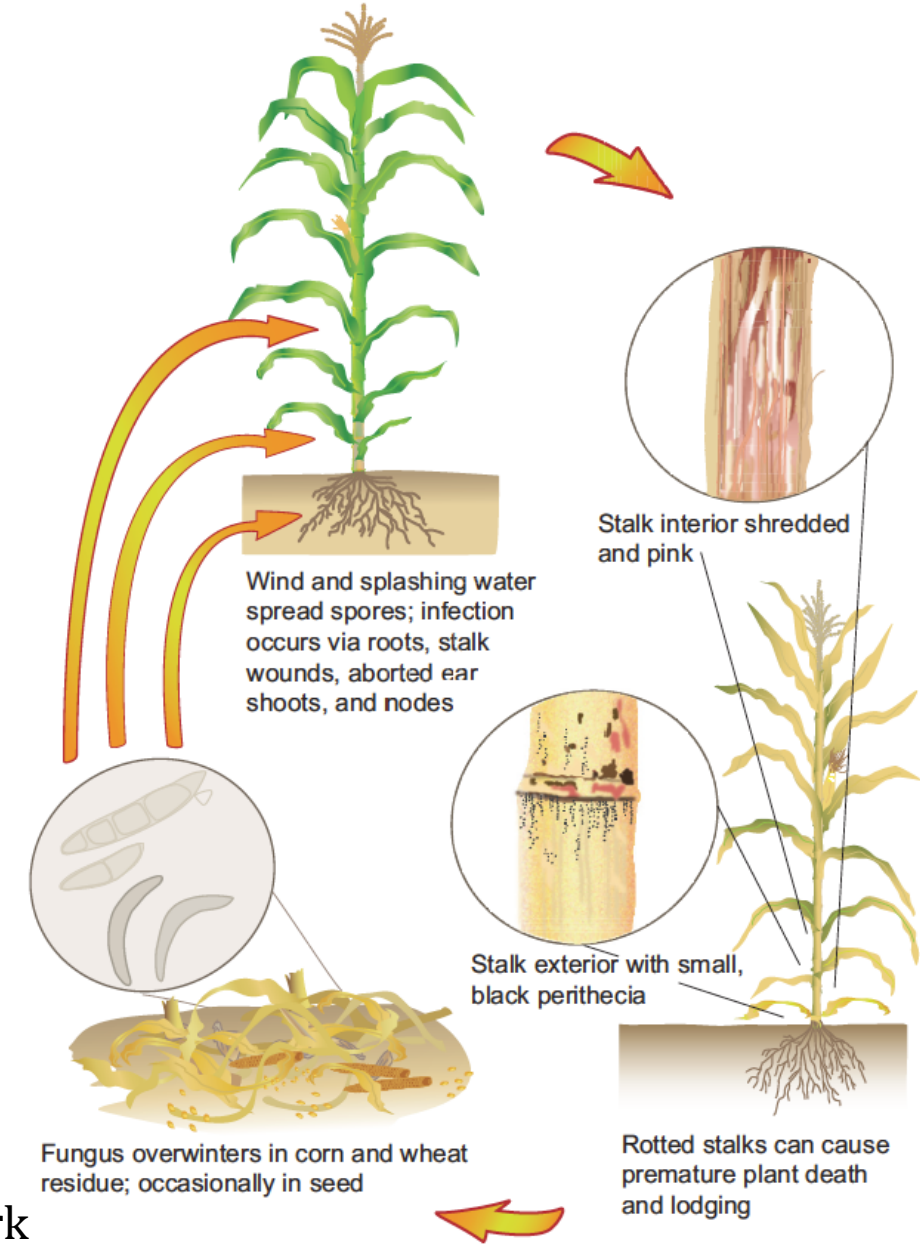
- Gibberella ear rot and stalk rot caused by *Fusarium graminearum*

- Deoxynivalenol (DON) / vomitoxin synthesis takes place alongside infection.

Ear rot cycle

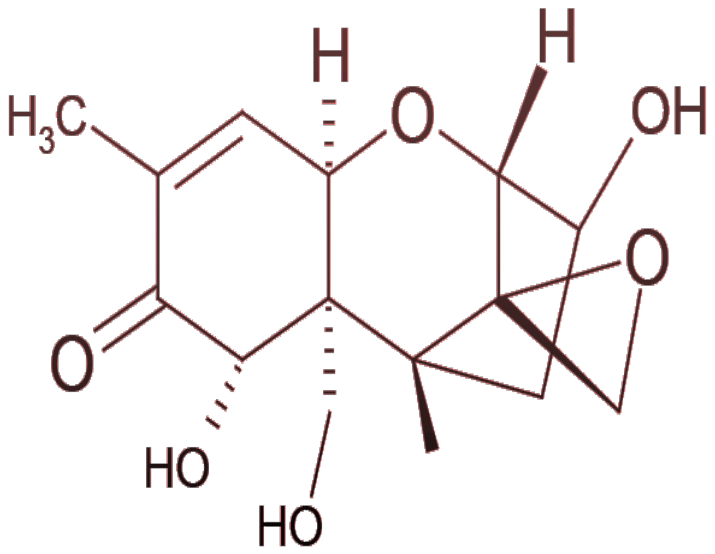


Stalk rot cycle

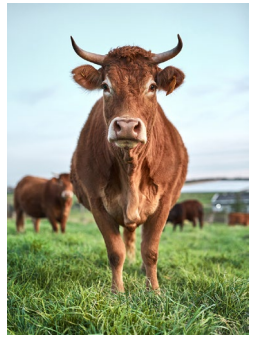


Source: Crop protection network

Mycotoxin and effects



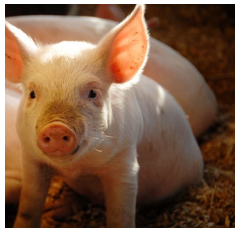
Deoxynivalenol (DON) or Vomitoxin



- Suppress immune response genes
- Upregulation of genes that lead to cell death

- Reduce feed intake in cows
- Lower milk production

- Exerts toxicity on the gastrointestinal tract
- Induces vomiting in pigs



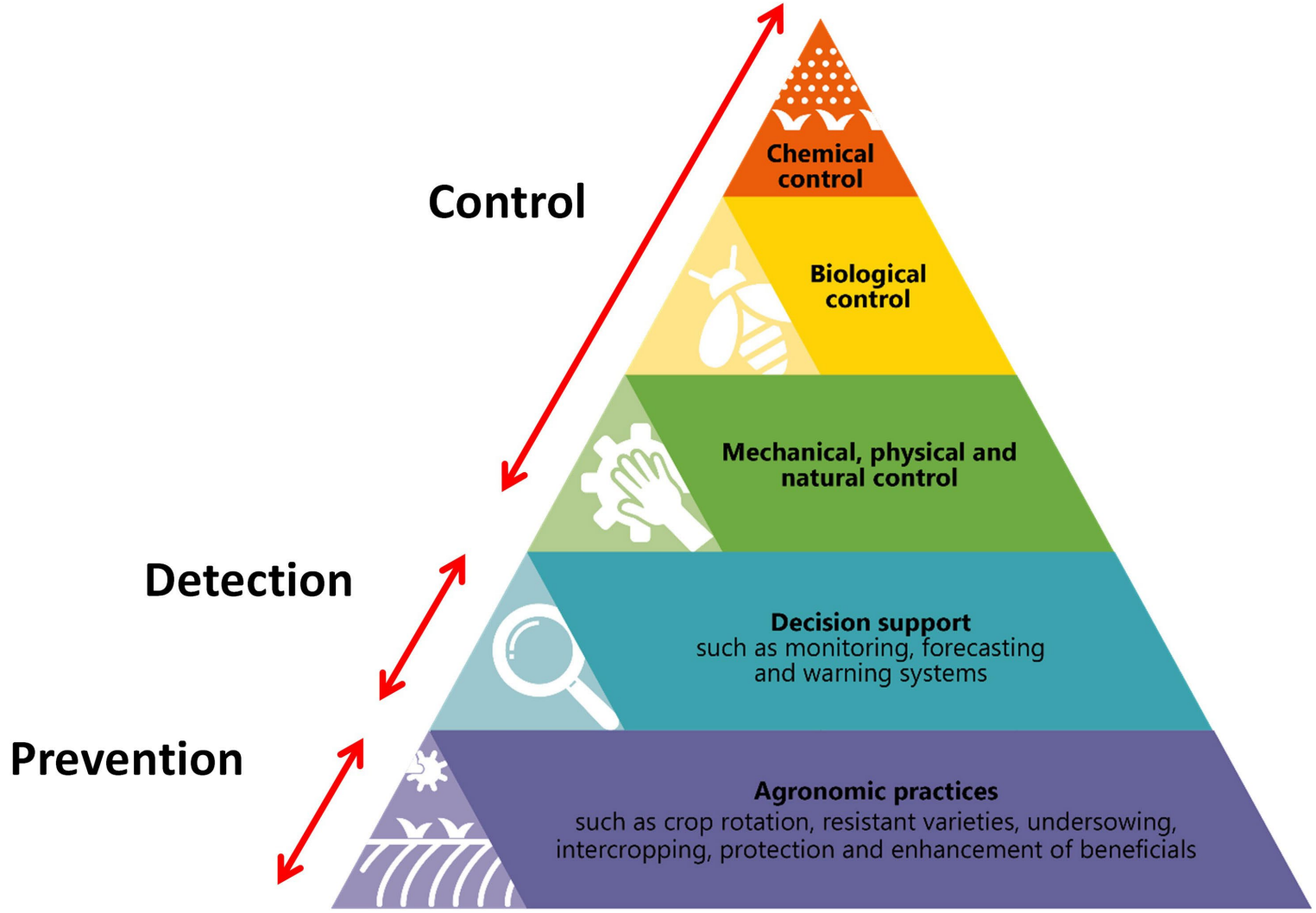
Mycotoxin Dietary Limit Guidelines

Summarized by Dr. John Goeser, PAS & Dipl. ACAN
Revised January, 2015

Potentially Harmful Toxin Levels for a Total Diet (DM)					
	Dairy	**Feedlot**	**Swine**	**Poultry**	**Equine**
Toxin Type	Values listed in blue are PPM, all other listed are in PPB				
Aflaxi n	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

Note: The table lists maximum concentrations for the total diet. These values were summarized from the literature cited below and conservatively chosen to represent the lowest values recommended without causing animals harm. Measured toxin is likely not the only type of toxin present in a sample; multiple toxins (including those not measured or masked toxins) may interact to further impact health and performance.

Integrated Pest Management (IPM) Pyramid



[1] Collier, 2023: Pest insect management in vegetable crops grown outdoors in northern Europe – approaches at the bottom of the IPM pyramid

Tips for integrated pest management in corn

- Hybrid selection
- Tillage or Residue Management
- Rotation (previous crop)
- Planting population
- Fungicide Programs
  - Greatest yield when foliar fungicides applied at VT[1]

[1] Wise et al. 2019. Meta-analysis of yield response of foliar fungicide-treated hybrid corn in the United States and Ontario, Canada

1. Field trials Set Up (Arlington, WI. 2020 & 2021)

S/N		Common name
1	B10B77SX	Brown Midrib Hybrid (BMR)
2	B08J81AM	Dual-purpose or Non-BMR

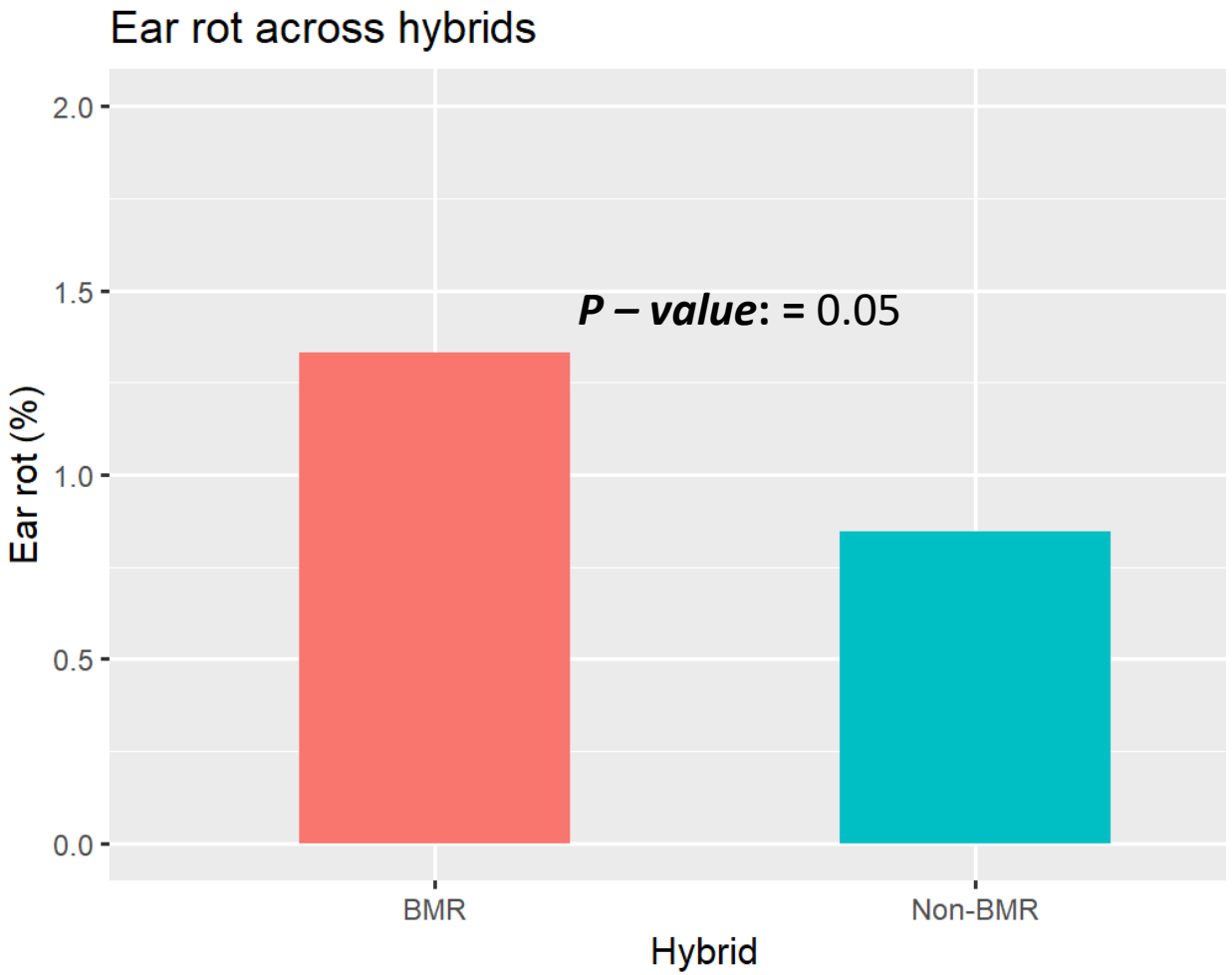
S/N	Tradename	Active ingredient(s)	Spray rate
1	Non-Treated Control	-	-
2	Headline AMP®	Pyraclostrobin and metconazole	1.05 liters per hectare at R1
3	Proline®	Prothioconazole	0.42 liters per hectare at R1
4	Fungicide program A	Confidential	0.75 liters per hectare in-furrow
5	Fungicide program B	Experimental program A followed by Proline® (prothioconazole)	0.75 liters per hectare in-furrow 0.42 liters per hectare at R1
6	Xyway®	Flutriafol	1.11 liters per hectare in-furrow
7	Xyway® followed by Proline®	Flutriafol followed by prothioconazole	1.11 liters per hectare in-furrow 0.42 liters per hectare at R1

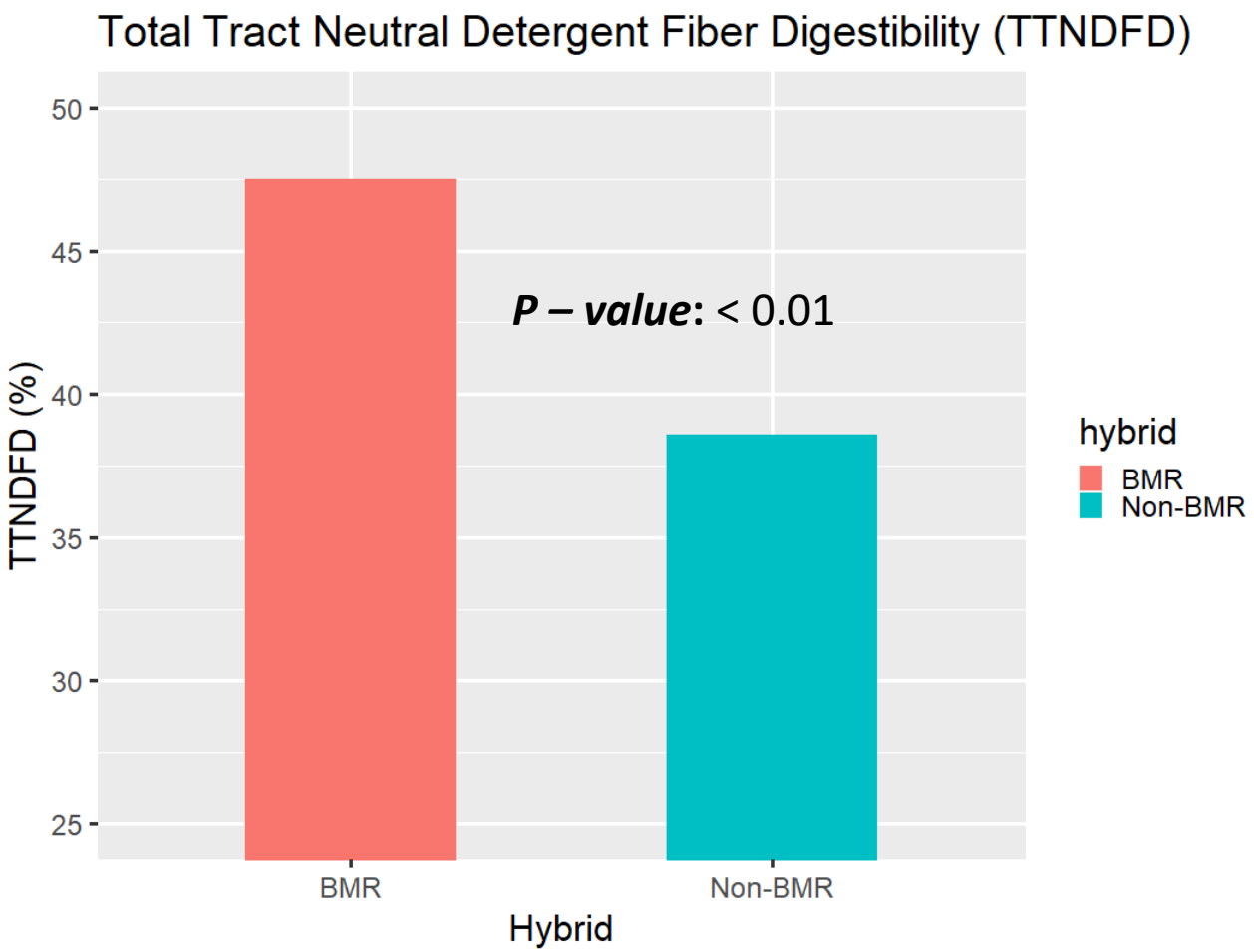
- 2 x 7 factorial arranged in a RCBD with 4 replicates (blocks)

Data Collected

1. Yield
2. Disease ratings taken throughout the growing season
   A. Ear rot and tar spot
3. Silage quality assessment by Rock River Laboratories, Watertown, WI.
   - Digestibility, fiber, starch levels, lignin
4. DON levels quantified with LC-MS/MS

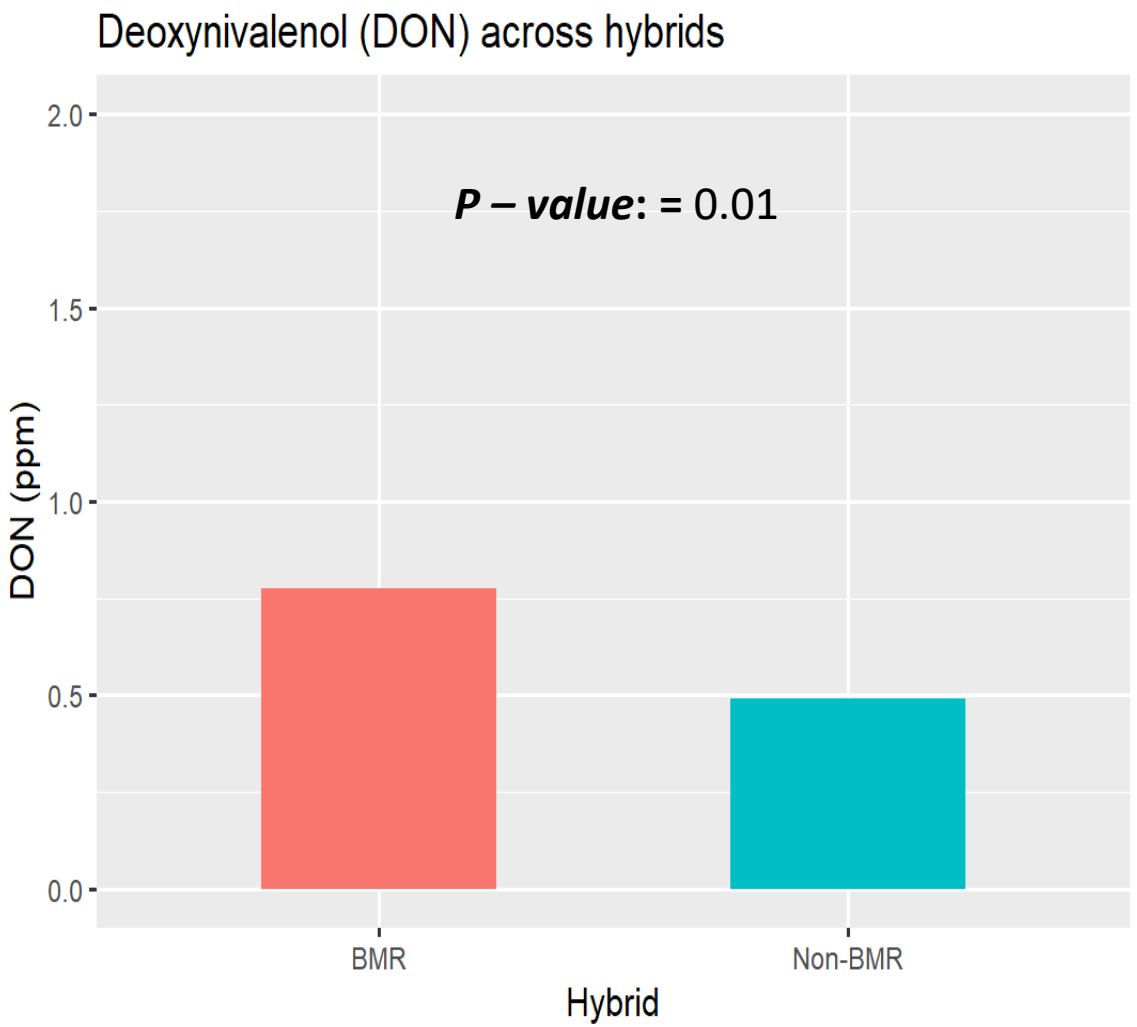
- Performed mixed model analyses of variance
- Means separated using Fisher's LSD (post–hoc).

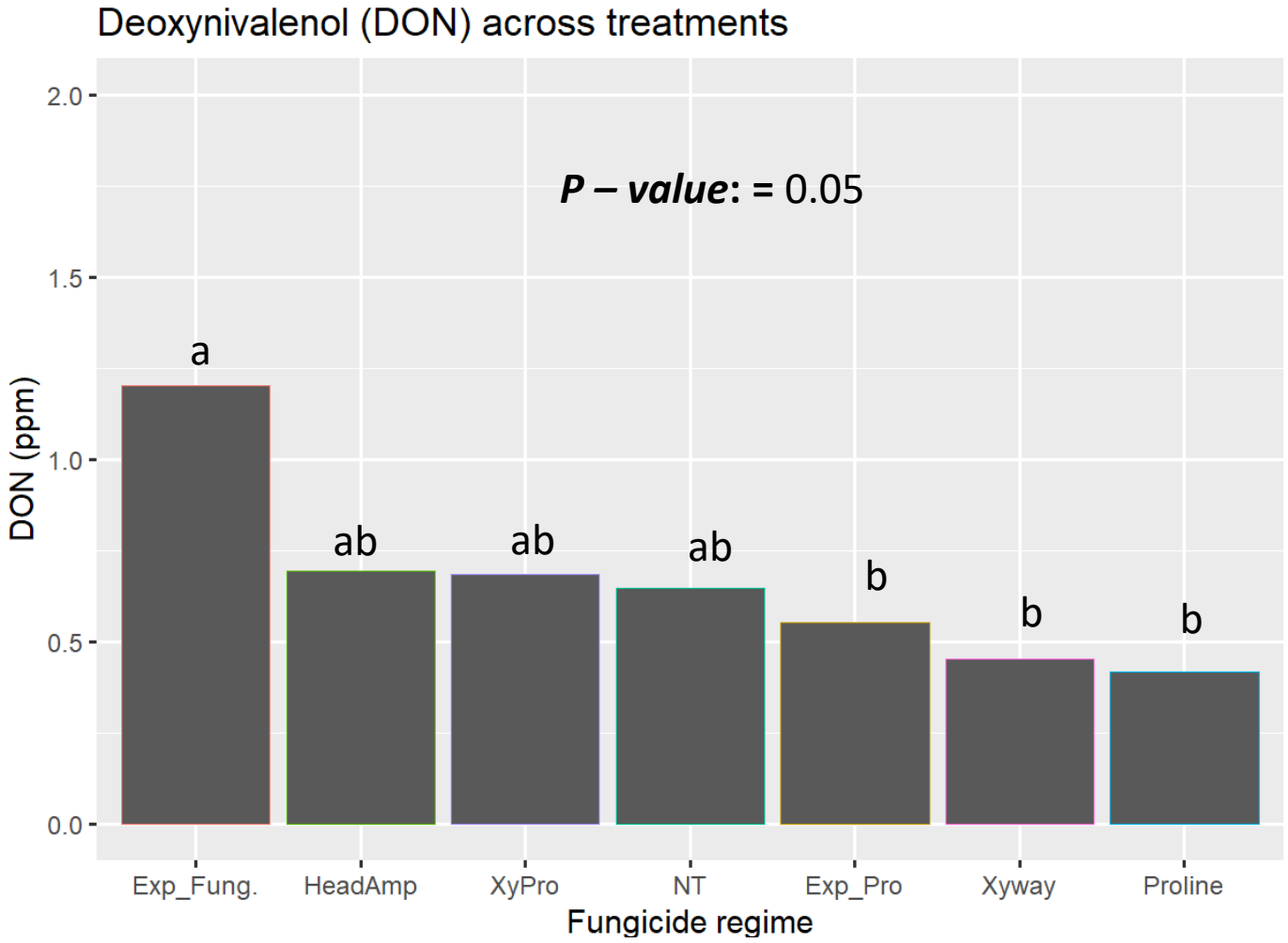




(Chibuogwu et al. 2023)

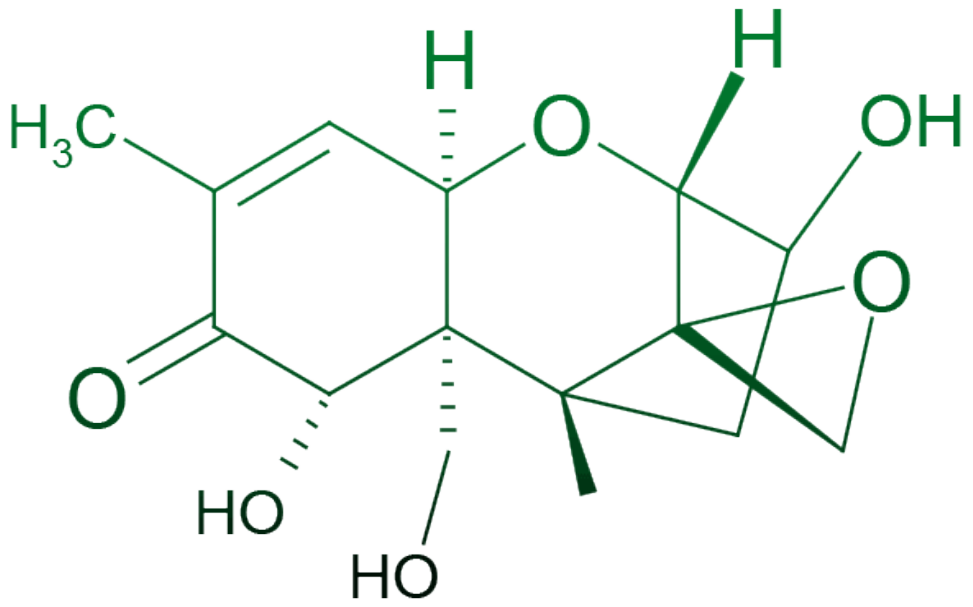
Hybrid and Treatment Effects on DON

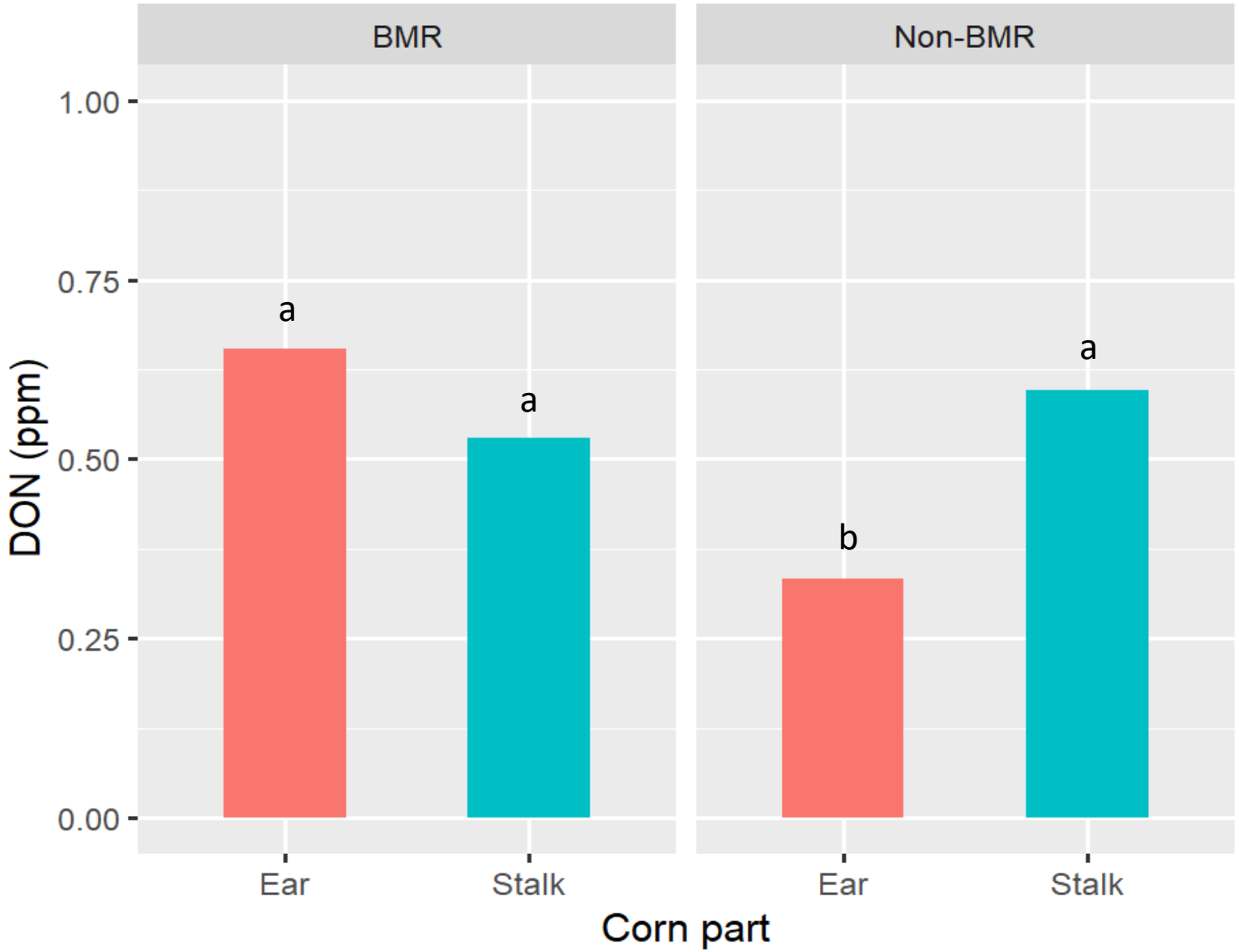




(Chibuogwu et al. 2023)

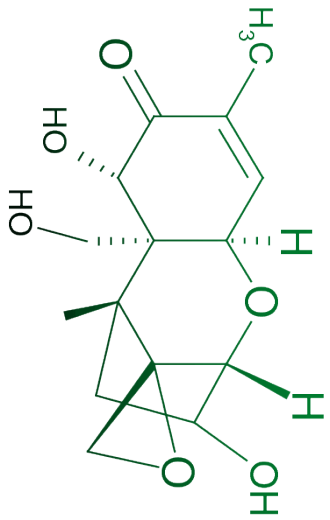
2. Where does DON accumulate in silage corn

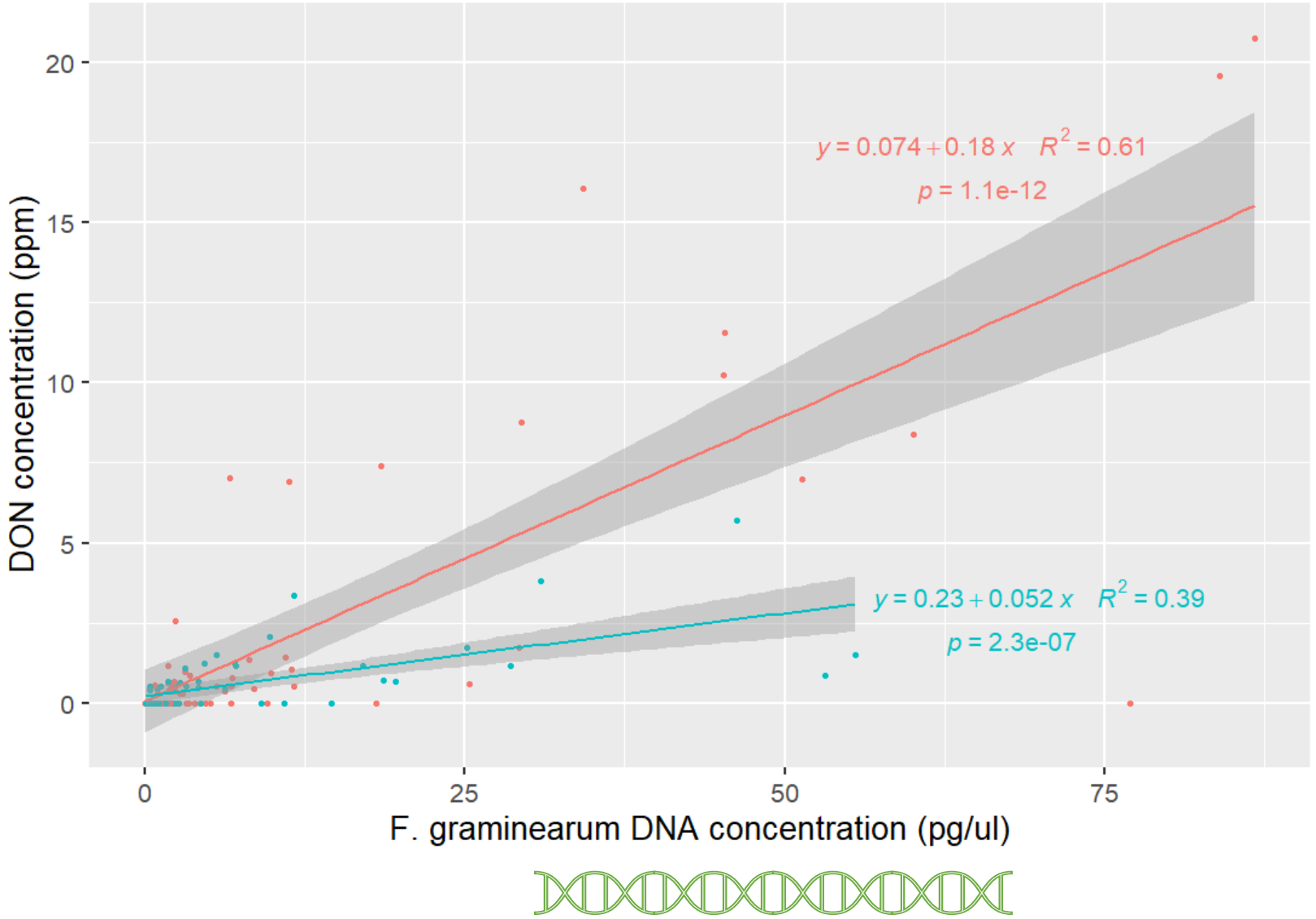




Chibuogwu et al. (2023)

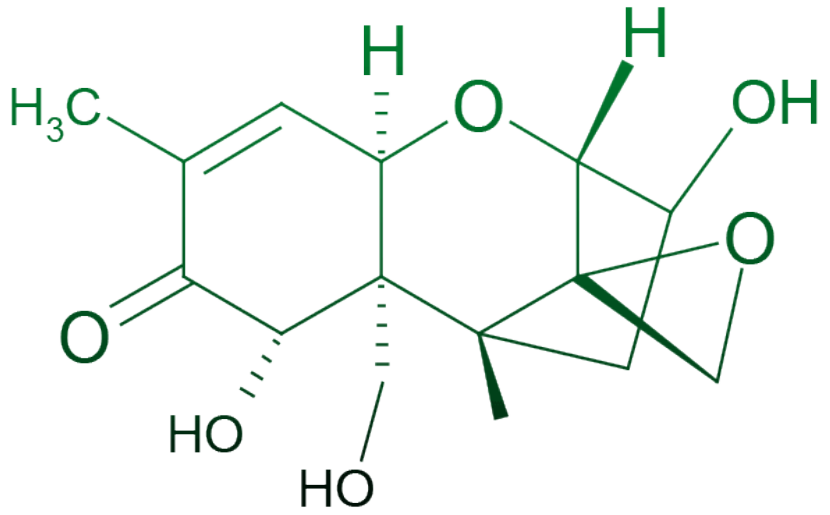
Fungus and Toxin Relationship in Corn Ears





(Chibuogwu et al. 2024)

What happens to DON during ensiling?



Source: Vikon precast

3. Ensiling experiment design

Years: 2020 and 2021

- Provide uniform ensiling conditions and are a realistic model system for silage fermentation - Johnson et al. 2005
- Vacuumed sealed 10” x 13” 3-mil Polyethylene vacuum chamber pouches.
- Filed with approximately 500g of chopped silage

Hybrids

- BMR - Brevant B10B77SX
- non-BMR - Brevant B08J81AMXT

Treatments

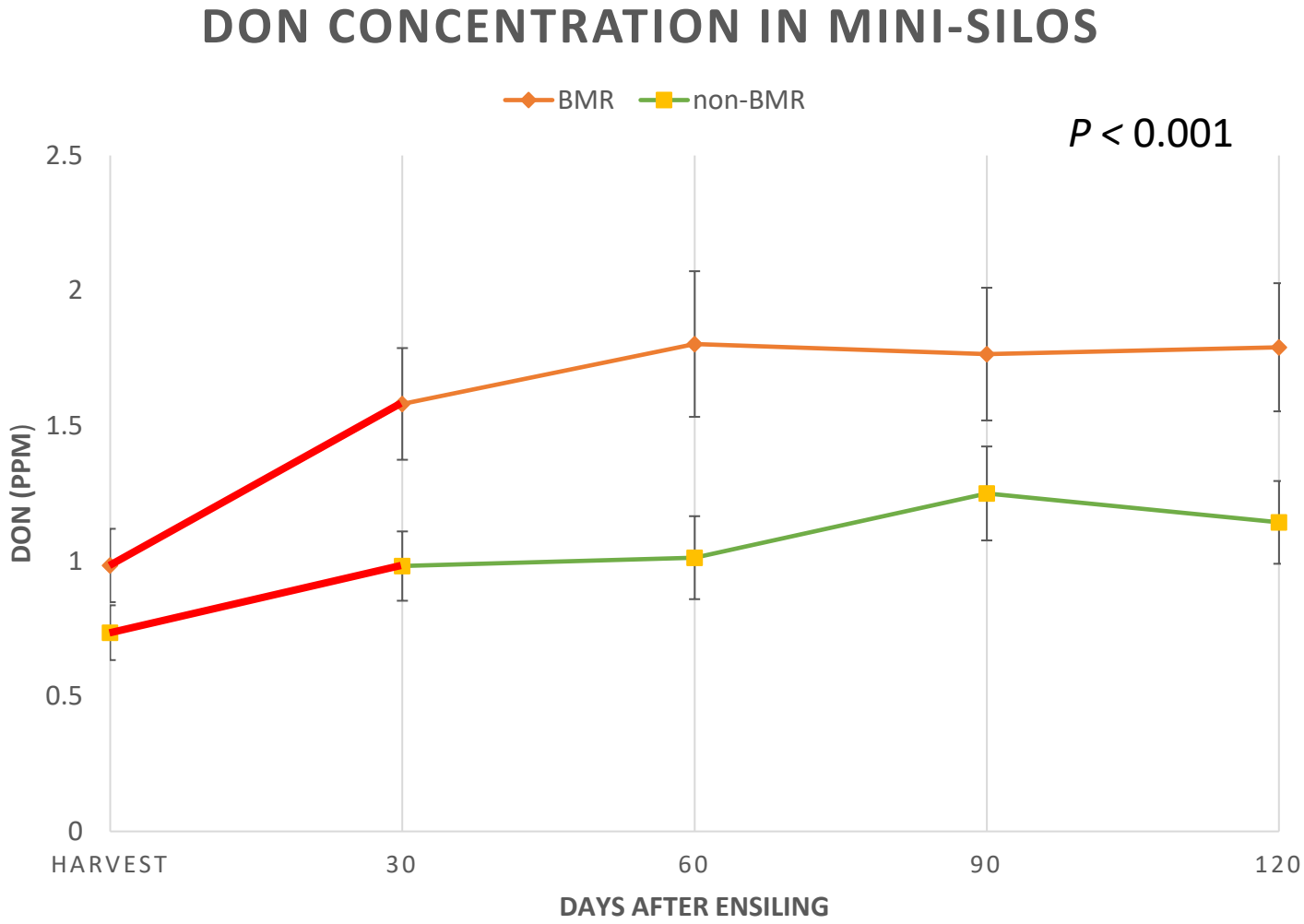
1. Nontreated Control
2. Proline at R1
3. Headline AMP at R1

In-Field Replications - 4 (blocks)

Ensiling Time points-

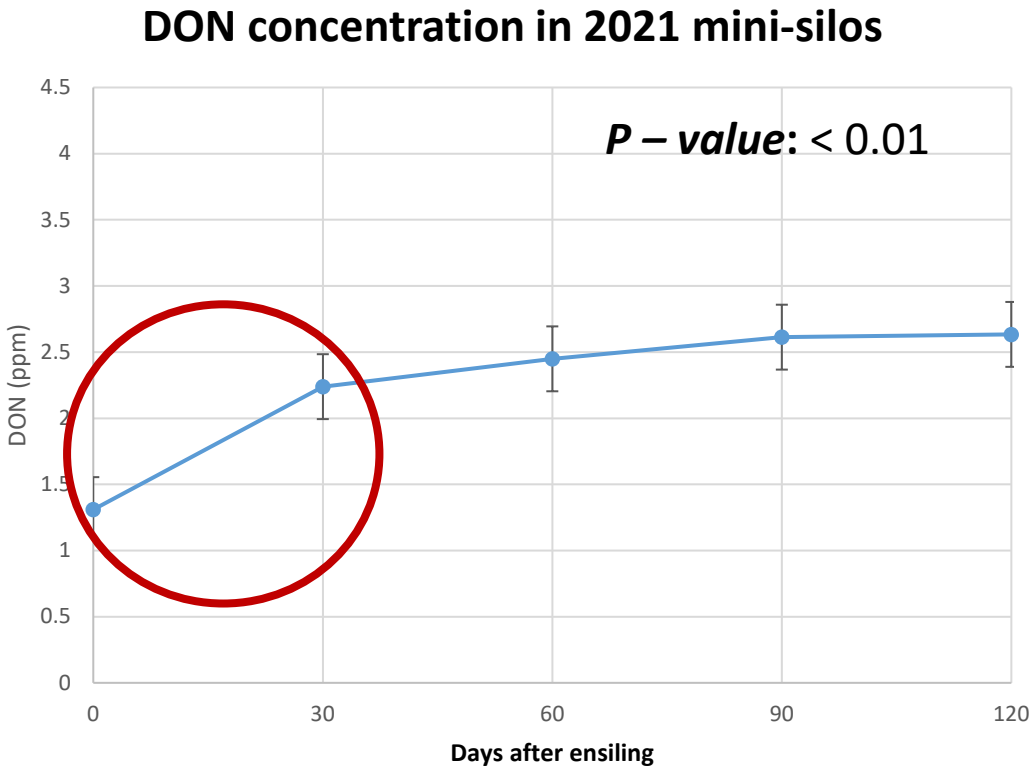
- 0, 30, 60, 90, 120 days

Toxin accumulation while ensiling corn silage



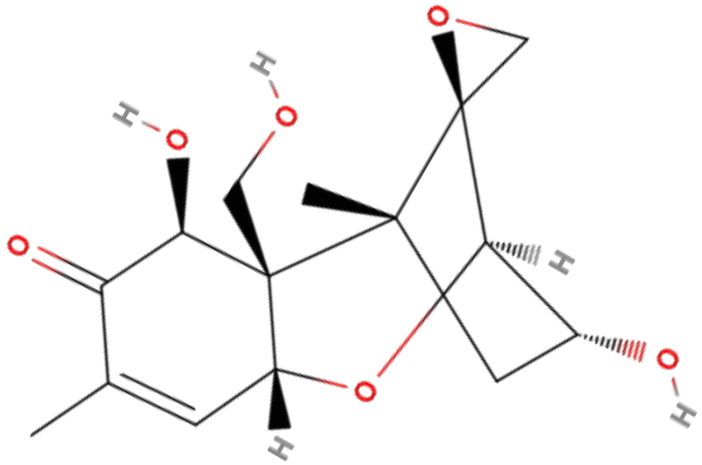
- Irrespective of low or high toxin year/environment, BMR hybrids have higher DON

- Increase in DON concentration between Day 0 and Day 30 after ensiling.
  - Important to test materials after 30 days.
  - Hypothesis about DON3G masking.

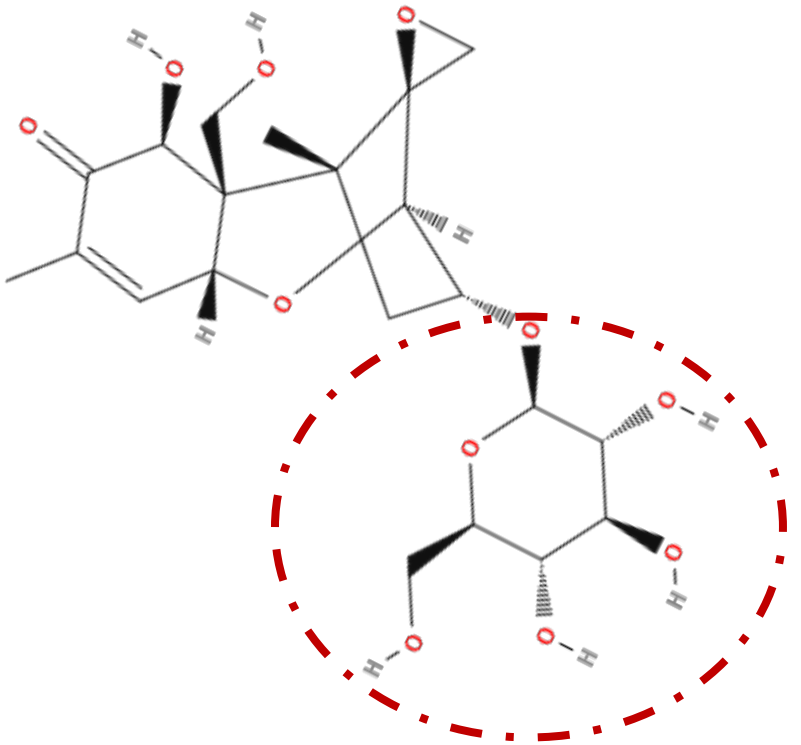


Metabolic protection in plants: Masking

Berthiller et al. 2005, 2009



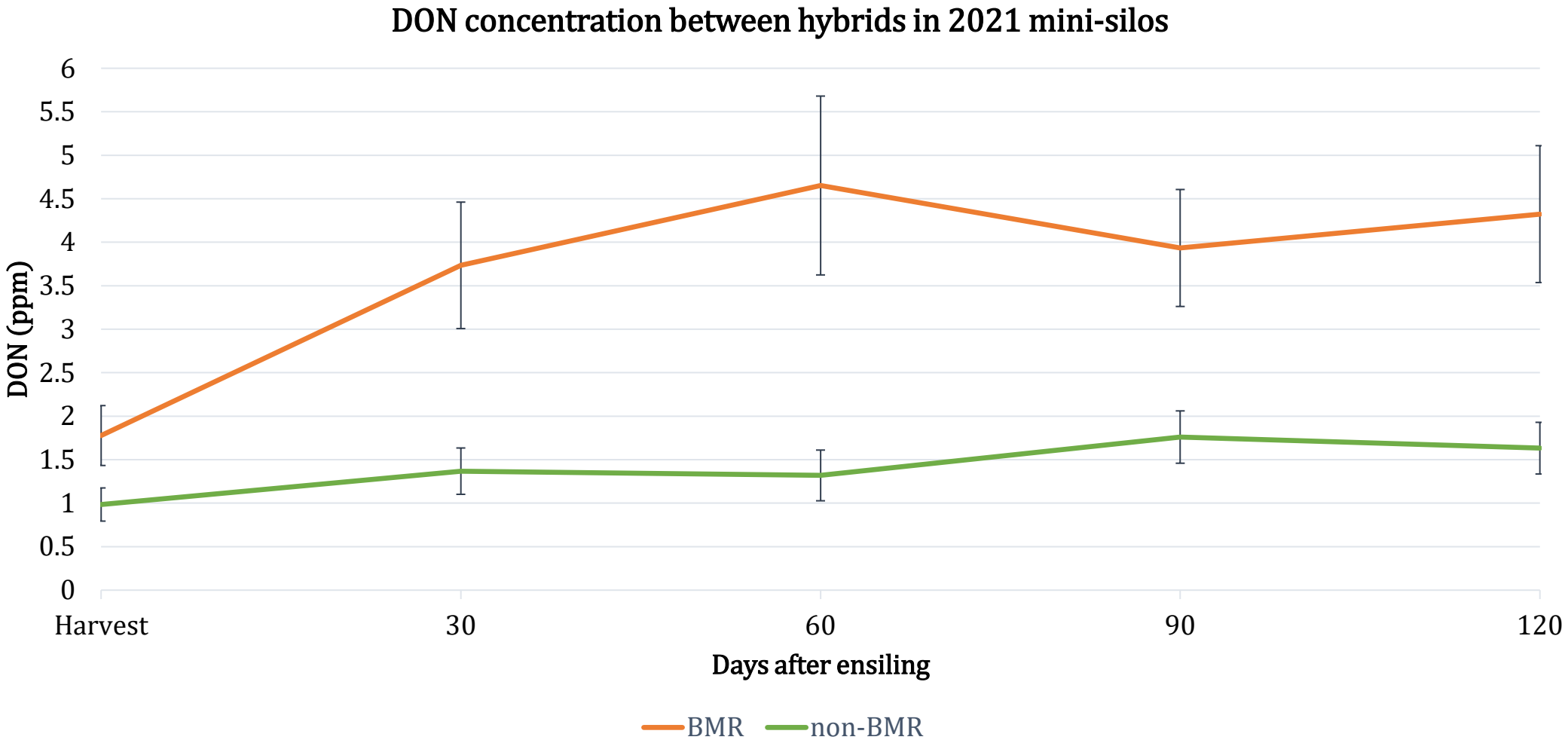
Deoxynivalenol (DON)



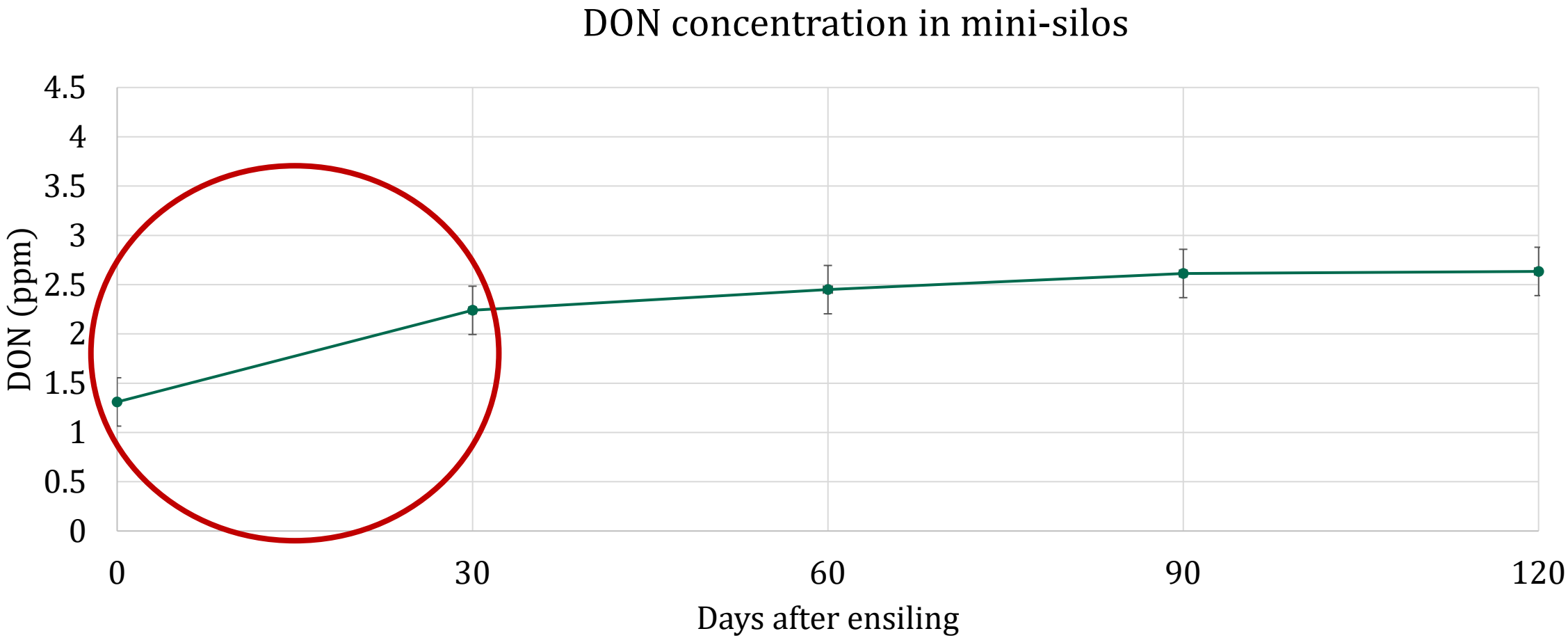
DON-3-Glucoside

2021

$P < 0.001$

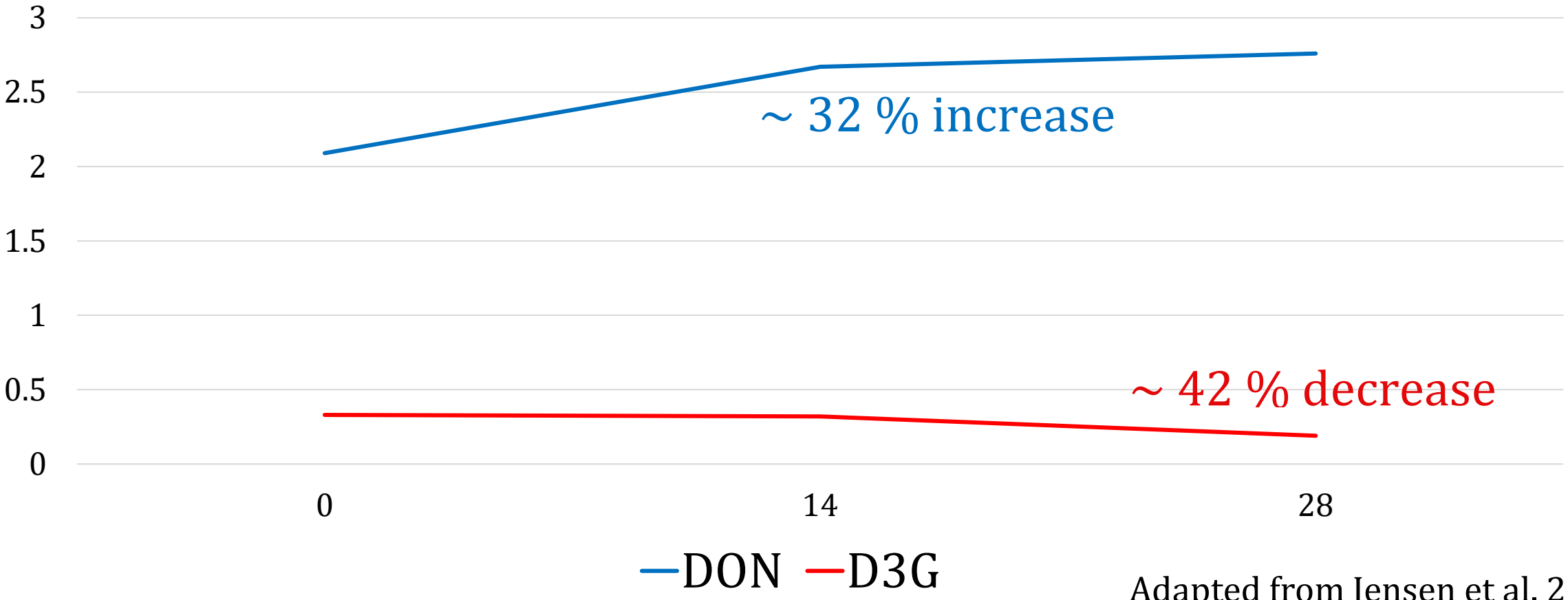

DON concentration between hybrids in 2021 mini-silos
DON (ppm)
6
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Harvest
30
60
90
120
Days after ensiling
BMR
non-BMR

3a. Exploring DON during the first 30 days in the silo



P – value: < 0.01

Effect of ensiling duration on the concentrations (µg/kg) of Fusarium mycotoxins



Adapted from Jensen et al. 2019.

Mini-silo experiments

Years: 2020 and 2021

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Treatments

1. Nontreated Control
2. Proline at R1
3. Headline AMP at R1

In-Field Replications - 4 (blocks)

Ensiling Time points-

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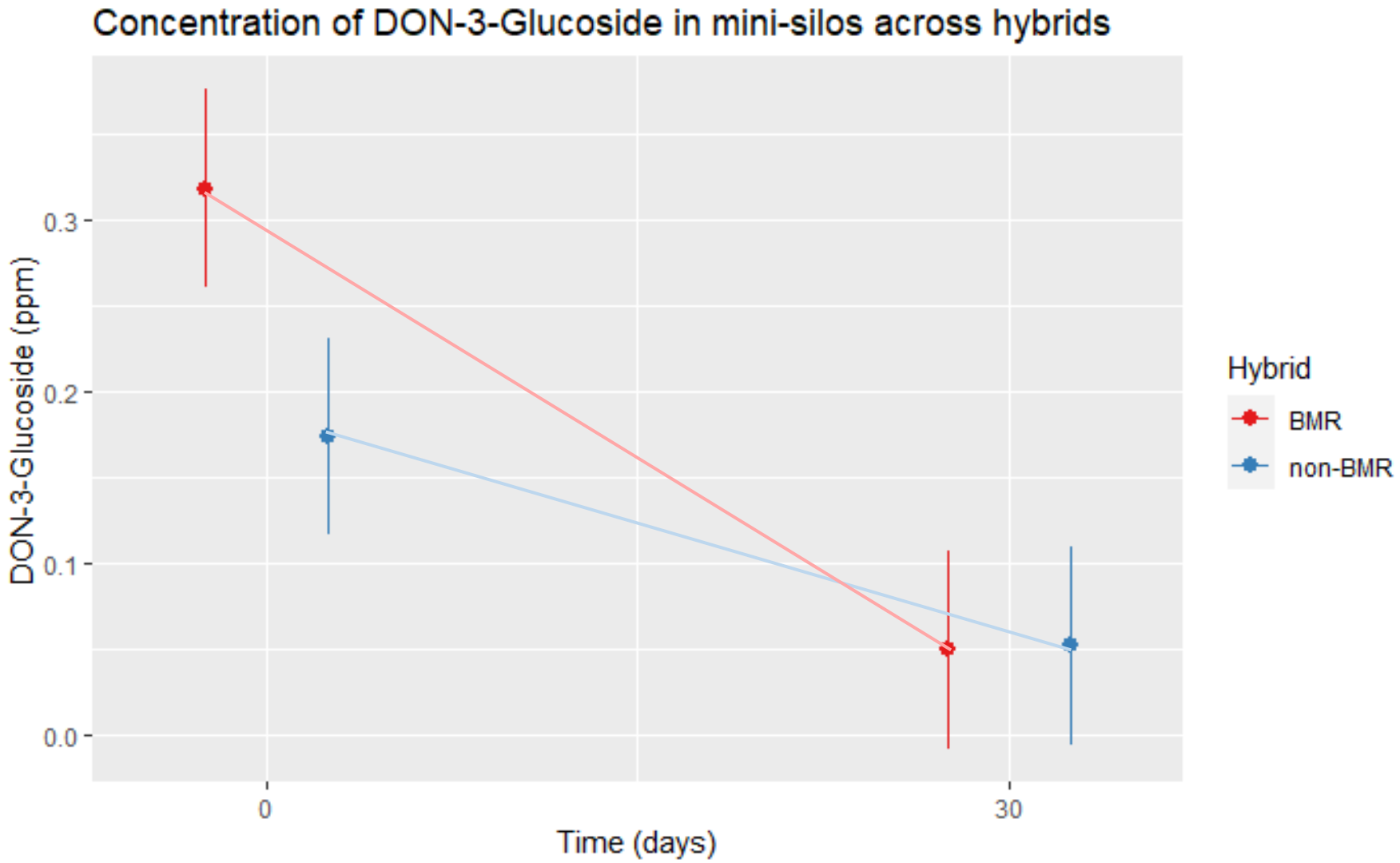
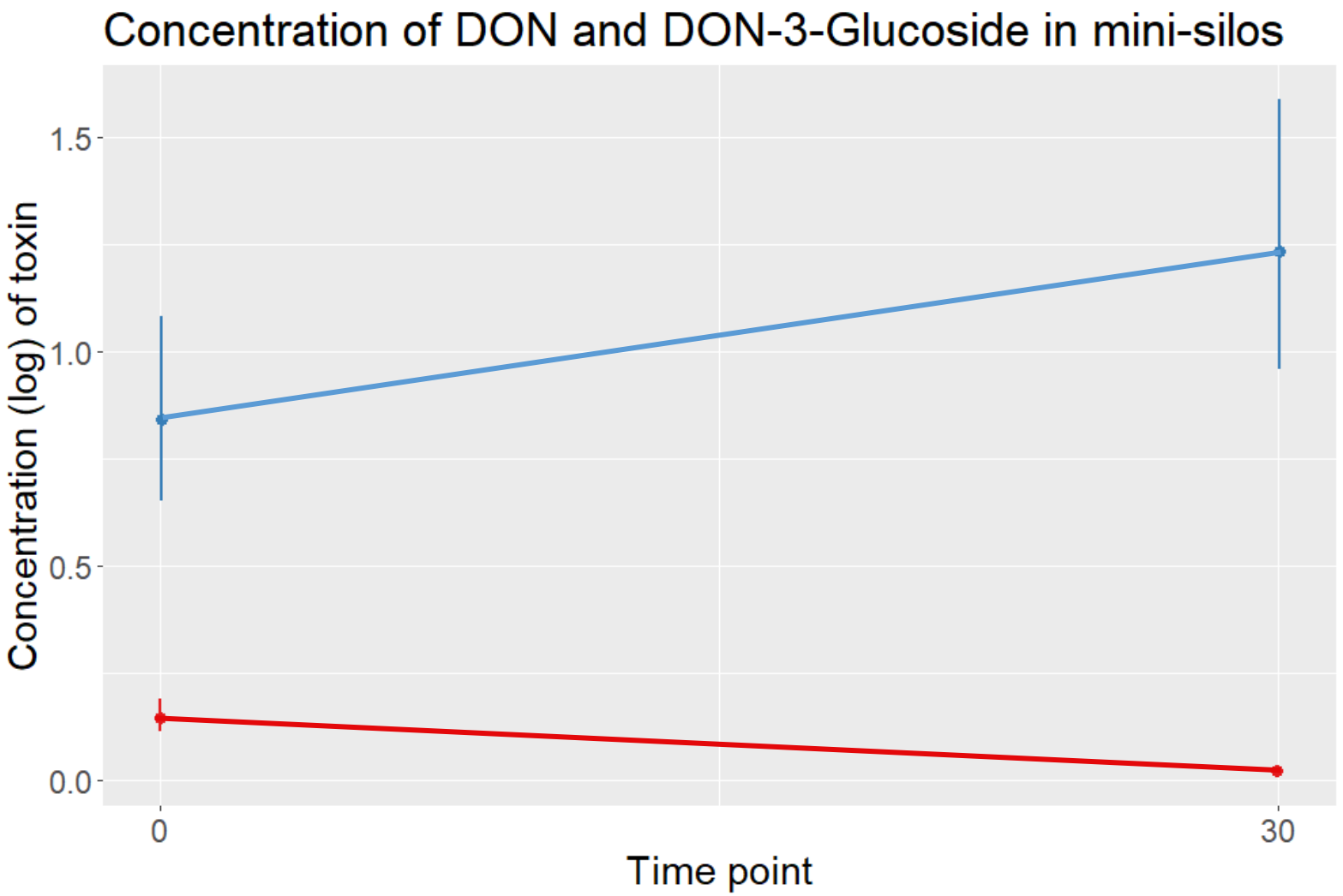
Exploring D3G during the first 30 days in the silo



- D3G metabolized faster in BMR compared to non-BMR.

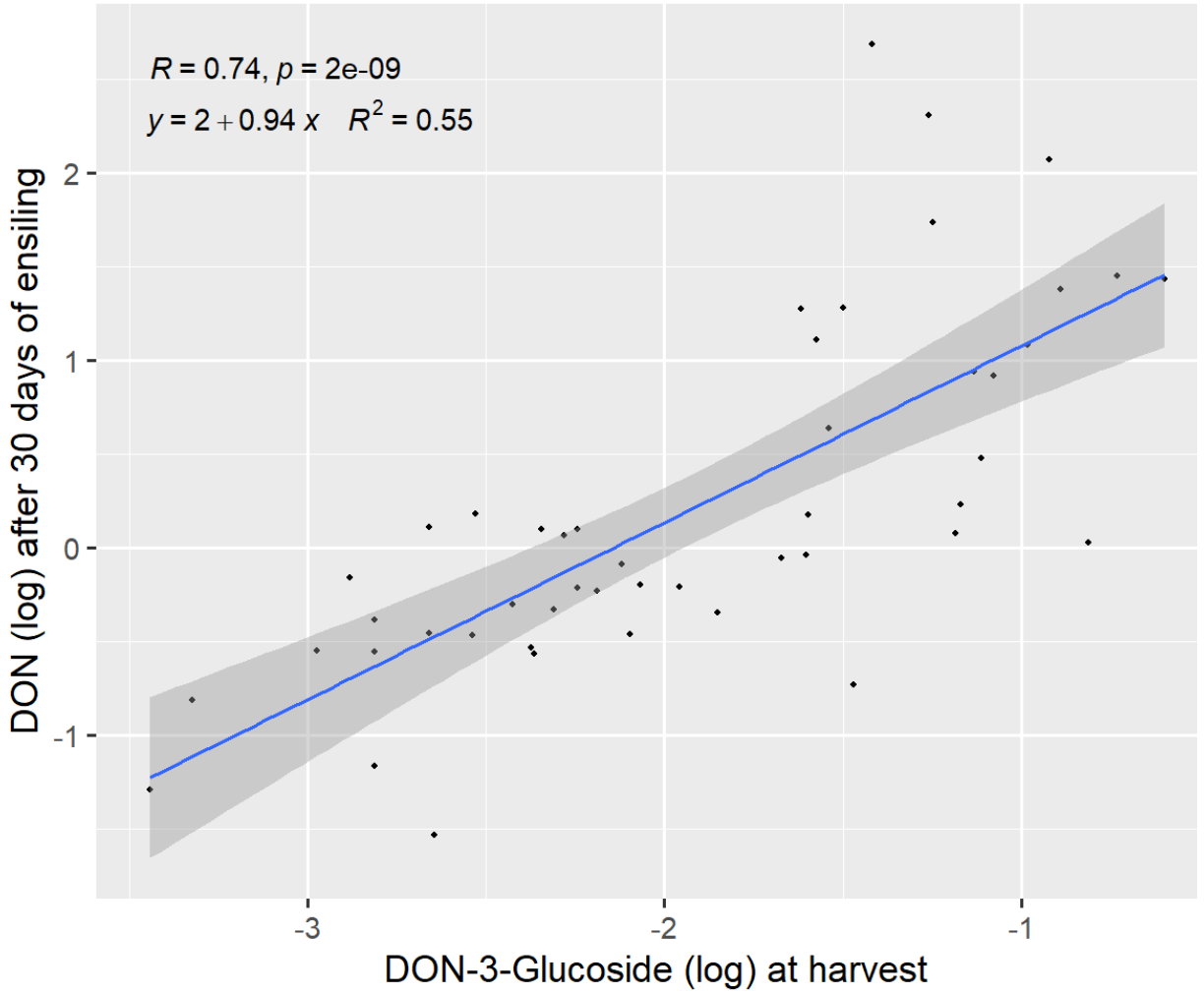
DON increases and corresponding D3G reduces

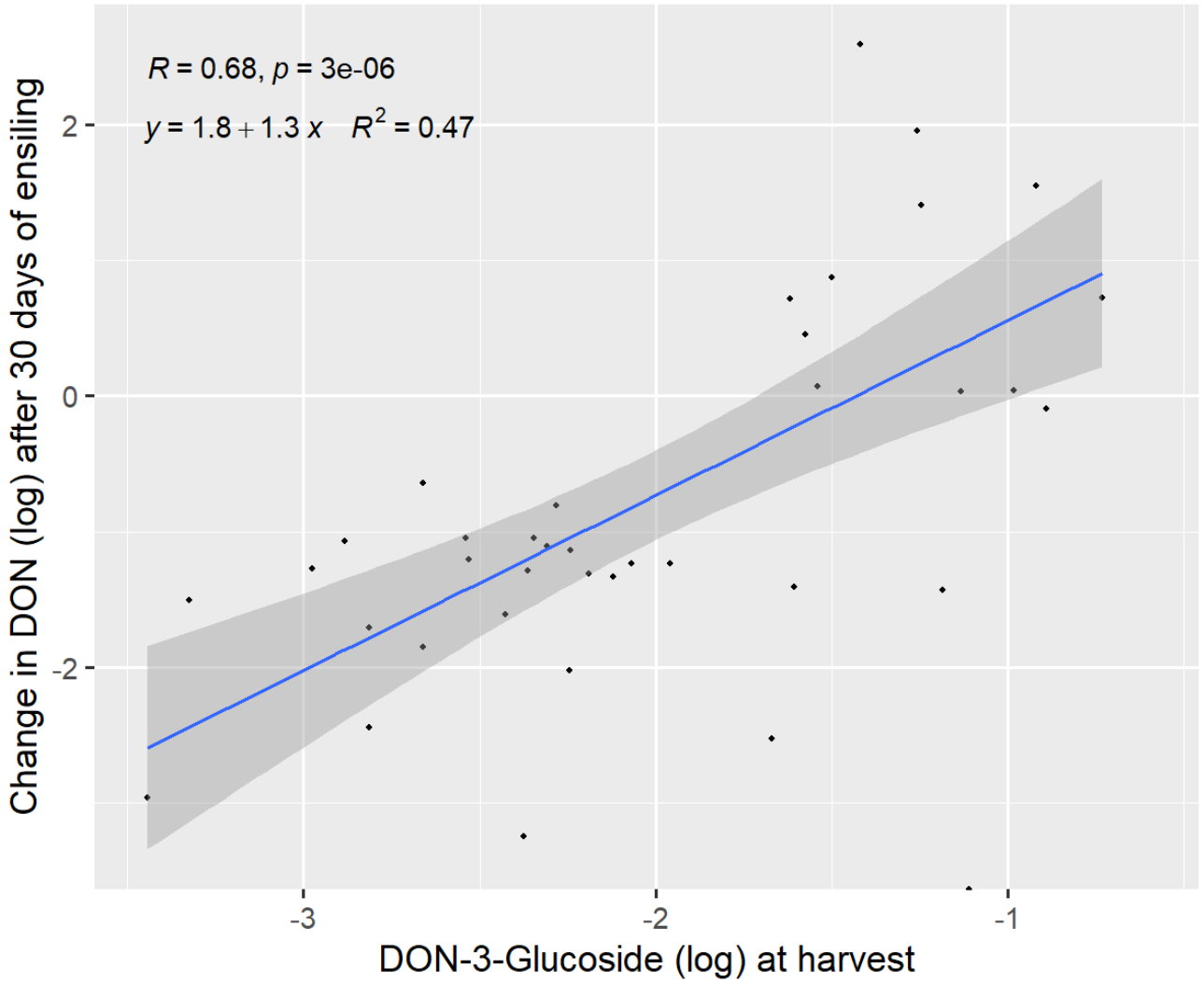


> 50 % increase

> 50 % decrease

Ensiling relationship between DON3G and DON





Chibuogwu et al. (2024)

Conclusions

- Hybrid selection is very important in the accumulation of DON during ensiling.
- During ensiling, change in DON over time is larger in BMR hybrids compared to dual-purpose hybrids.

- Change in D3G during ensiling is more in BMR compared to dual-purpose hybrid.
- Significant difference in D3G concentrations between hybrids at harvest, but not so much at time 30.

- Increasing DON can be partially explained by D3G metabolism.

Recommendations and Takeaways

- Scout for in-season diseases (Gibberella ear rot and stalk rot) in silage corn fields.
- Quantify DON levels at harvest and DON levels after 30 days or before feed out.
  - Low DON at harvest may correspond to relatively lower DON in the bunker with time.
  - Hybrid choice is key in the reduction of total DON levels
    - Switch if having problems with DON in your fields.

- Track moisture and pH levels in the silos and ensure fermentation is ongoing.
- Test for D3G and other masked forms of DON

Q&A

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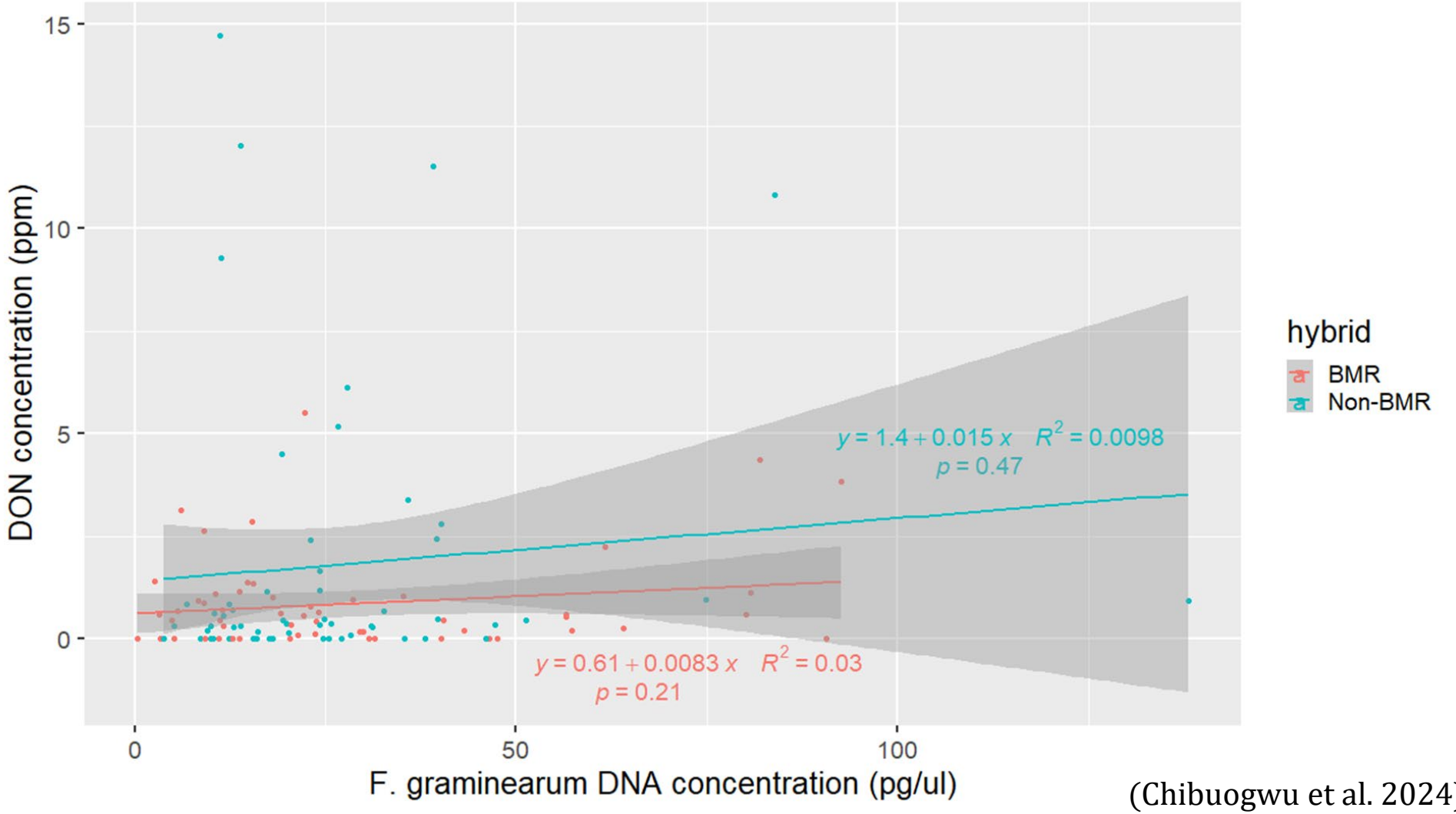

(Chibuogwu et al. 2024)