Advances in the Epidemiology of Fusarium Head Blight and Applications in Prediction Models

Erick De Wolf and Mizuho Nita

Department of Plant Pathology

Kansas State University

Presentation Outline

- Brief history of the forecasting effort supported by the USWBSI

- Current modeling initiatives

- Future priorities

The Big Picture

- General understanding the conditions that trigger FHB epidemics

- Observations of weather associated with FHB epidemics from early 1900's


Symptoms of FHB on wheat

Global Effort to Predict FHB and DON

- Tremendous effort to develop prediction models
- China, Argentina, Canada, Brazil, Italy and US

History of US Efforts

- The early years
  - 1999 - 2000: Initial models developed
  - 2001: Individual states deploy models
  - 2002 - 03: Second generation models developed

Large Scale Deployment

www.wheatscab.psu.edu

Third Generation Models 2006-2007

- Use pre-athesis weather to predict scab epidemics >10% field severity

- Spring wheat
  - RH
  - Host resistance level

- Winter wheat
  - Temp and RH combination

www.wheatscab.psu.edu
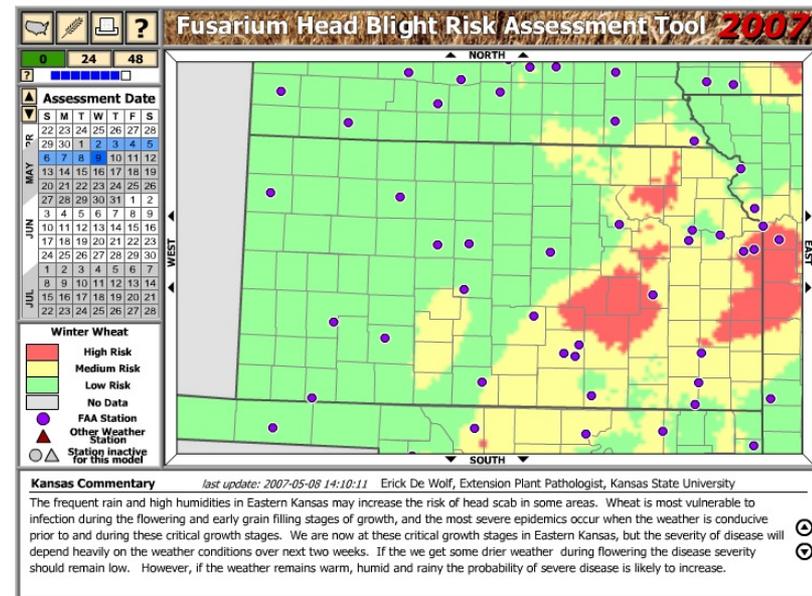
Current Modeling Initiatives

- Expansion of the effort to predict both disease epidemics and DON

- Mechanistic and empirical modeling approaches

- Capitalize on the strengths of both approaches

Data Available

- ## 110 Cases
  - hourly weather, anthesis and DON level
- ## Representing 7 states and 14 varieties
  - IN, OH, MI, MN, ND, PA and SD
  - Winter and spring wheat

Overview of the Mechanistic Modeling Process

- Develop a conceptual model of the disease cycle

- Develop model prototypes using STELLA software

- Parameterize model with published research results

Conceptualized DON Model

| Inoculum index | X | Infection efficiency | X | Pathogenesis index | = | DON risk index |

Conceptualized DON Model

Inoculum index	X	Inoculum efficiency	X	Infection index	=	DON risk index

DON >2 ppm

1.0

Risk index

Critical threshold

0.0
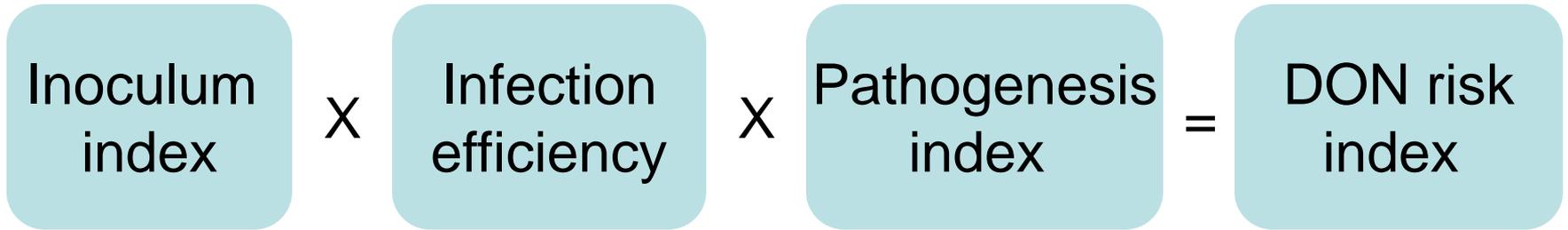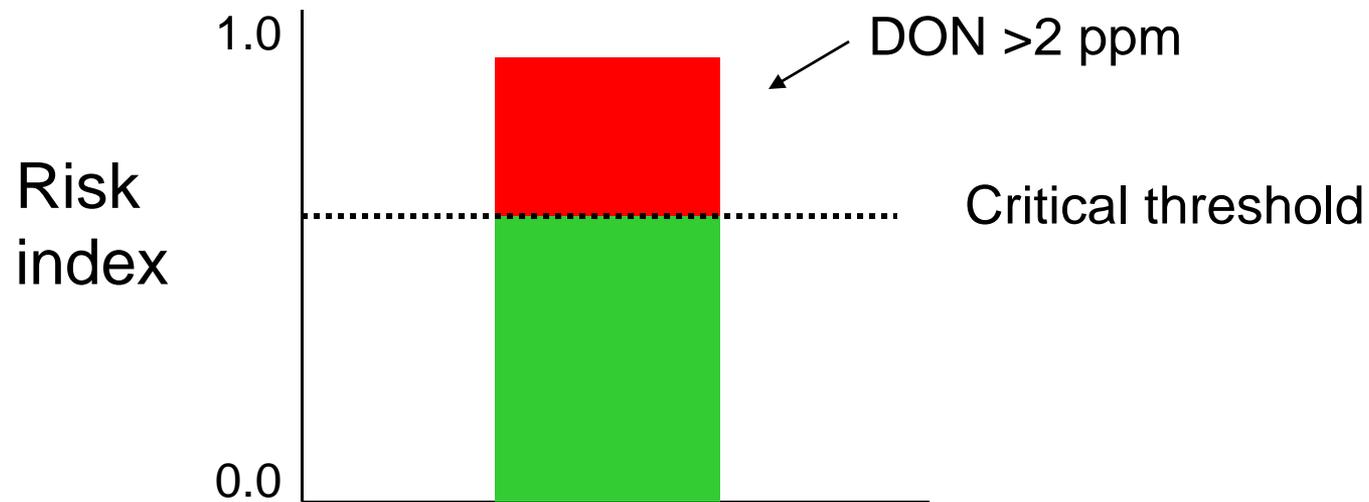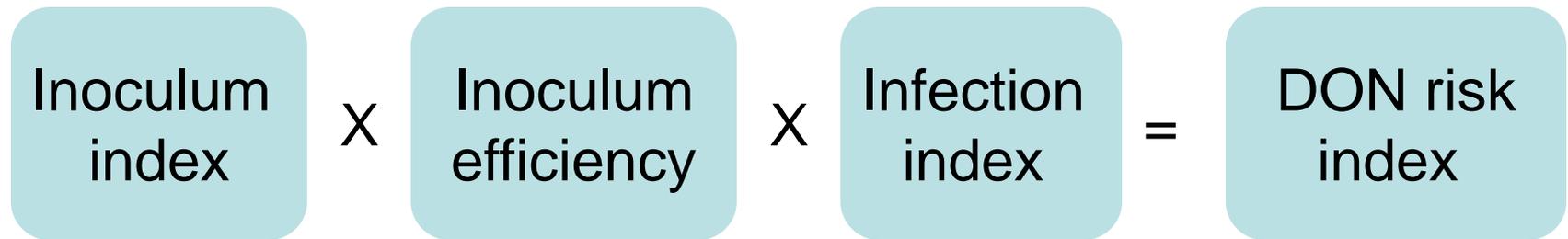
Mechanistic Model Components

- ## Inoculum index
  - Perithecia development (T, RH & Time)
  - Macroconidia production
  - Spore release and survival

- ## Infection efficiency
  - Germination rate

- ## Pathogenesis index
  - Infection (T, RH, GS, & Time)
  - Colonization (T, Time, & Host resistance)
  - DON degradation (Time)

Mechanistic Model Results

- Accuracy of mechanistic models for DON (2 ppm) in winter and spring wheat

Accuracy %		
Overall	Sensitivity	Specificity
73.6	53.3	81.2

n=110

Overview of Empirical Approach

- Design variables that represent potential relationships with DON

    - 2 ppm threshold for binary response

- Variable selection (Kendall's tau)

- Develop candidate models using logistic regression

Correlation results

Non-parametric measures of association (Kendall's tau)

Time period relative to anthesis	Spring Wheat	Winter Wheat
10 to 7 days pre	Average RH RH>90%	. .
7 day pre	Average RH Average Temp Max Temp .	Average RH . . Min Temp
3 day during	. Max Temp .	Average RH . Min Temp

Summary of Logistic Models

Variables			Accuracy (%)			
Production Class	Pre-anthesis	During anthesis	AUROC	Overall	Sensitivity	Specificity
Spring	RH, T, Rain	Max T, Rain	0.96	76.6	83.9	58.3
Winter	RH,TRH	Min T, RH, Rain	0.91	79.6	85.2	74.1
Spring	RH, T	..	0.88	80.4	91.2	50.0
Winter	RH, TRH, T9-30	..	0.90	79.6	85.2	74.1

Future Priorities

- Validate empirical models for DON with additional observations

- Link inoculum level, and environment with disease and DON

- Infection efficiency of the inoculum

- Degradation of DON effects of host resistance and environment

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