Fungicides for FHB Management:
Past, Present, and Future

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For fungicides to be effective, we need:

- Safe products with fairly short PHI's
- High efficacy in reducing FHB and DON
- Optimum rates and timing of application
- Optimum application techniques
- Reasonably priced products
Fungicides for Control of FHB – A Review


- Reviewed international literature: 1977-1995
  - 41 citations
  - 21 different fungicides evaluated for FHB control, alone or in combinations
  - “Most showed potential for reducing disease incidence and severity, but results varied greatly from test to test”
  - “Reduction of mycotoxins was very inconsistent”
Examples of Fungicides Tested 1977-1995

- **Benzimidazoles:** Benomyl, carbendazim, thiophanate methyl, thiabendazole
- **Multi-site activity:** Mancozeb, chlorothalonil
- **Triazoles:** Triademnol, triadimefon, bromuconazole, flusilazole, fenbuconazole, propiconazole, tebuconazole
- **Carboximides:** Prochloraz
1st Published US Fungicide Test

Barry Jacobson, 1977, Phytopath. 67:1412-1414

- Tested:
  - Benomyl,
  - Benomyl + mancozeb,
  - MBC (methyl benzimidazole carbamate)

- Winter wheat at the Univ. of Illinois
- Applied 2x
- 70% reduction in FHB with benomyl or MBC
- 50% reduction with benomyl + mancozeb
Use of Benomyl, Mancozebs

- **Benomyl (Benlate):** alone wasn’t effective against leaf diseases; added mancozebs
- **Benlate:** WP, a mess to mix and apply
- **Epidemics of 1990s:** only registered products available that could be applied at flowering
- **Expensive:** relative to wheat price at time and generally had to be applied 2x
- **Discontent with their use:** sparked multi-state effort to evaluate fungicides
Timetable 1988-1996

- **1988:** First US registration of a foliar triazole with some activity against FHB:
  - propiconazole (Tilt), only to flag leaf emergence

- **‘94-’97:** Multi-state projects to identify most effective fungicides

- **1995:** ND, SD, MN request Sec. 18 for Tilt to be applied at flowering; denied

- **1996:** Europeans identify tebuconazole (Folicur) as one of more effective products (Suty and Mauler-Machnik)
Timetable 1997-2001

- **1997:** First National Fusarium Head Blight Forum, St. Paul, MN. Fungicide Technology Network formed
- **1997:** ND, MN, SD request Sec. 18 for Folicur fungicide; denied (Crisis declared)
- ‘98-’00: USWBSI Uniform trials: 5-9 trts evaluated; 5 wheat classes, 7 -15 states
- **2000:** Strobilurins registered in US
- **2001:** Benlate discontinued by DuPont
‘02–’03: More new chemistries, rates, timings, added to USWBSI uniform trials

Some eliminated:
- poor efficacy
- tendency to increase DON
- or termination by crop protection industry

2003: Uniform trial results with Folicur from 1998-2003: average reduction of FHB index = 39.4%; DON reduction = 27.4% 
- (D. Hershman and G. Milus, 2003 Nat. FHB Forum talk)
Folicur (tebuconazole)

- **Sec. 18 emergency exemptions** for FHB control in multiple states 1998-2007. Why?
  - No other fungicides registered that had comparable, consistent control
  - EPA wouldn’t grant full registration because of a special review of triazole fungicides

  - “We may conclude that at the present time we do not have fungicides to control FHB with a very high efficacy, as has been obtained for rust or powdery mildew. Among the active ingredients in the tested fungicides, tebuconazole was the best”. 
Where are we now?

- **2007**
  - Proline (prothioconazole) was registered by the U.S. EPA for control of FHB and other wheat diseases

- **2008**
  - Caramba (metconazole), Folicur (tebuconazole), and Prosaro (prothioconazole + tebuconazole) all registered on wheat
How do Proline, Prosaro, and Caramba stack up against Folicur?

“The toolbox is full”

- For the first time ever, in 2009, wheat growers in many states will have access to multiple fungicides that are effective against Fusarium head blight.

- Have we reached the peak of control yet?
Not quite there, yet

- Paul et al. (2008)
  - Prosaro = 52% reduction of FHB index and 42% reduction in DON relative to untreated control
  - Proline = 48% reduction of FHB index and 43% reduction in DON
  - Caramba = 50% reduction of FHB index and 45% reduction in DON

What does the future hold for fungicide control of Fusarium head blight?

• How long will current fungicides be effective……fungicide resistance?

• Will there be new, more effective fungicides available?
What is the risk of *F. graminearum* resistance to triazole fungicides?

- Fungicide Resistance Action Committee (FRAC) – classifies triazole fungicides as having a **medium risk** of fungi developing resistance to them

- Already several cases of phytopathogenic fungi with resistance to triazole fungicides
What is the risk of *F. graminearum* resistance to triazole fungicides?

Klix et al. (2007) – Evaluated triazole sensitivity in *F. graminearum* isolates collected over several years in Europe – Reported a decrease in sensitivity to tebuconazole and metconazole from 1994 to 2004

Fig. 4. Relationship between EC$_{50}$ values and time expressed as years that fungal strains were isolated. EC$_{50}$ values were obtained from the interpolations depicted in Fig. 3.

Will new chemistries be available?

- Li et al. (2008)
  - JS399-19 (2-cyano-3-amino-3-phenylacrylyc acetate)
  - Belongs to the cyanoacrylate fungicide group
  - In field and greenhouse tests in China, JS399-19 was more effective controlling FHB than carbendazim (an MBC-group fungicide)


Fig. 1. Chemical structure of JS399-19.
Will new chemistries be available?

- In 2008, a few “numbered” compounds were evaluated by a few university researchers.

- Continued testing is important!
THE FUTURE: Not the time to be complacent

- Current fungicides still only providing ~50% reduction of FHB index and ~40% reduction in DON

- Potential erosion of triazole fungicide sensitivity

- New chemistries with improved efficacy and new modes of action are still needed
Questions?

U.S. Wheat & Barley Scab Initiative

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