Changes in performance of SBR fungicides over the years and new management strategies adopted in Brazil

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Brazilian Agricultural Research Network

- Embrapa Headquarters
- 9 Thematic Research Centers
- 13 Ecorregional Research Centers
- 15 National Centers by Products
- 3 Services
Embrapa Soybean
1. Introduction


3. Sensitivity monitoring tests

4. Resistant cultivars

5. Perspectives for 2009/10
Anti Rust Consortium

First report of ASR in Brazil - May 2001

Anti Rust Consortium (ARC) was created in 2004

Annual meetings to discuss and define the recommendations

Warning system - 100 labs in the main soybean producing regions

Update the website’s warning system in real time
Crop management in the winter season

- Eliminate volunteer plants;
- Avoid second summer crop;
- "Free host period" (FHP) - no soybeans in the winter season
## Free host period

<table>
<thead>
<tr>
<th>State</th>
<th>Jun</th>
<th>July</th>
<th>August</th>
<th>September</th>
<th>October</th>
<th>November</th>
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<tbody>
<tr>
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<td>MT</td>
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<td>MG</td>
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<td>15</td>
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<tr>
<td>SC</td>
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<td>15</td>
<td>1</td>
</tr>
</tbody>
</table>

- **TO**: Available from June 15 to November 1.
- **PA**: Available from July 1 to October 15.
- **MA**: Available from August 15 to November 1.
- **BA**: Available from September 15 to November 1.
- **GO**: Available from October 15 to November 1.
- **MT**: Available from July 1 to October 15.
- **MS**: Available from August 15 to November 1.
- **DF**: Available from September 15 to November 1.
- **SP**: Available from July 1 to October 15.
- **MG**: Available from August 15 to November 1.
- **PR**: Available from July 1 to October 15.
- **SC**: Available from August 15 to November 1.
Strategies adopted by ARC

- **Crop Management in the winter season**
  - Eliminate volunteer plants;
  - Avoid Second summer crop;
  - “Free host period” (FHP) – no soybeans in the winter season (July - Sep)

- Early sowing with early maturity cultivar

- Monitor disease presence in the field and region

- Fungicides at first symptoms or preventive

- Resistant cultivars
Fungicide soybean market evolution in Brazil

Million U$}

Fungicide market in Brazil
U$1.5 B (2008)

- Soybean: 54%
- Cotton: 5%
- Citrus: 4%
- Others: 8%
- Coffee: 4%
- Wheat: 6%
- Corn: 6%
Grain losses due to SBR

Grain losses (Million U$)

Growing season


drought
Labeled fungicides

Number of labeled fungicides

6 triazoles
2 strobilurin
5 triazoles + strobilurin
1 triazole + benzimidazole
1. Introduction

2. Network of fungicides from 2003 - 2009

3. Sensitivity monitoring tests

4. Resistant cultivars

5. Perspectives for 2009/10
Objective:
compare fungicides in the same situation (later in the season)

Material and methods (standard protocols):
✓ randomized complete block with four replications (6 rows wide and 6 m long);
✓ two or three sequential application (maximum interval 21 days), starting at R2 or at first symptoms (vegetative);
✓ CO$_2$ pressurized back pack sprayer;
✓ 150 - 200 l ha$^{-1}$;
✓ severity assessment in the application time and at R5-R6;
✓ yield
✓ all soybean region (Universities, Embrapas, foundations, and private extension companies)
DMI + QoI x DMI - 2003/2004

Growing season 2003/2004

Control (%) vs. Fungicides (DMI+QoI, DMI (1), DMI (2))
DMI + QoI x DMI - 2004/2005

Growing season 2004/2005

Control (%)

Fungicides

DMI+QoI  DMI (1)  DMI (2)

Control (%)

0  20  40  60  80  100

Mean
Mean±SE
Min-Max
Outliers
Extremes
Growing season 2005/2006

<table>
<thead>
<tr>
<th>Fungicides</th>
<th>Control (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DMI + QoI</td>
<td>80 ± 10</td>
</tr>
<tr>
<td>DMI (1)</td>
<td>60 ± 5</td>
</tr>
</tbody>
</table>
Fungicides were grouped according to efficacy and DMI (1) was the only straight triazole grouped with premix of triazoles and strobilurin.

Favorable for epidemics outbreaks

Crop protection 28:774-782 (2009)
DMI + QoI × DMI – 2007/2008

Growing season 2007/2008

- Preferable use of premix of triazoles and strobilurins in MT, MS and GO
- Avoid sequential application of triazoles
<table>
<thead>
<tr>
<th>Fungicides</th>
<th>Control (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DMI + QoI</td>
<td>Mean±SE</td>
</tr>
<tr>
<td>DMI (1)</td>
<td>Min-Max</td>
</tr>
<tr>
<td>DMI (2)</td>
<td>Outliers</td>
</tr>
</tbody>
</table>

**Growing season 2008/2009**
1. Introduction
2. Network of fungicides from 2003 - 2009
3. Sensitivity monitoring tests
4. Resistant cultivars
5. Perspectives for 2009/10
Sensitivity monitoring tests

Bayer CropScience monitoring data are supporting FRAC recommendation (http://www.frac.info/)

2005 until 2009 - detached leaf method

Within the first 6 hours of germination no significant sterol biosynthesis can be detected

The EC$_{50}$ (half maximal effective concentration) value is used to compare among the regions and during season time
Sensitivity monitoring tests

- **2005/06**
  - $EC_{50}$: 0.15
  - range: 0.02 - 0.52 ppm

- **2006/07**
  - $EC_{50}$ mean: 0.73
  - range: 0.17 - 2.69 ppm

- **2007/08**
  - $EC_{50}$ mean: 0.65
  - range: 0.04 - 3.9 ppm

- **2008/09**
  - $EC_{50}$ mean: 0.63
  - range: 0.07 - 4.50 ppm
Sensitivity monitoring tests

The less sensitive parts of the *P. pachyrhizi* population disappeared in the winter season period.

back-shift / sensitivity recovery observable between seasons

Londrina - Paraná

EC50 values within the growing season

1 ppm

15 – 28 fev 01 – 15 mar 16 – 31 mar
Why does this selection happened?

<table>
<thead>
<tr>
<th>Fungicide Classes *</th>
<th>Fungicide Risk</th>
<th>Combined Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>benzimidazoles</td>
<td>high = 3</td>
<td>3</td>
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<tr>
<td>dicarboximides</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>phenylamides</td>
<td></td>
<td>9</td>
</tr>
<tr>
<td>QoI fungicides</td>
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<td></td>
</tr>
<tr>
<td>carboxamides</td>
<td>medium = 2</td>
<td>2</td>
</tr>
<tr>
<td>SBI fungicides</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>anilinopyrimidines</td>
<td></td>
<td>6</td>
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<tr>
<td>phenylpyroles</td>
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</tr>
<tr>
<td>phosphorothiolates</td>
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</tr>
<tr>
<td>multi site fungicides</td>
<td>low = 1</td>
<td>1</td>
</tr>
<tr>
<td>(e.g. dithiocarbamates)</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Copper, Sulphur</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>MBI-R inhibitors</td>
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<tr>
<td>SAR inducers</td>
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</tbody>
</table>

| Pathogen risk        | low = 1       | medium = 2    | high = 3      |
|----------------------|---------------|---------------|
| Pathogen groups *    | seed borne pathogens (e.g. *Pyrenochaeta* spp., *Ustilago* spp.) | soil-borne pathogens (e.g. *Phytophthora* spp.) | rust fungi |
|                      | *Erysiphe graminis* | *Botrytis cinerea* | *Rhynchosporium secalis* | *Septoria tritici* |
|                      | *Penicillium* spp. | *Magnaporthe grisea* | *Venturia inaequalis* | *Mycosphaerella fijiensis* |
|                      | *Phytophthora infestans* |               |               |                 |
Why does this selection happened?

- Large number of applications, curative applications;
- Use of straight azole in sequential applications;
- Underrate;
- Large areas treated with the same product
Market share of foliar fungicides (%)
1. Introduction


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Resistant cultivars

BRSGO 7560 - maturity group 7.5

Source: [(Tracy x Abura) x (D67 x R48)] x Embrapa 59
Single recessive major gene (PI 203398)
Genetic and molecular biology 31:505-511 (2008)

Recommendation: same than susceptible cultivars
fungicides at first symptoms or preventive

Advantage: stability in cases of delayed control
Resistant cultivars

BRSGO 7560  
Susceptible
Resistant cultivars

TMG 801 – maturity group 8.2
TMG 803 – maturity group 8.7

Source: different major genes
(Rpp2, Rpp4 or Rpp5)

Recommendation:
scouting until R3;
only apply fungicide before if you have symptoms otherwise apply at R3;
scouting for second and third reapplications

Advantage:
reduce the number of fungicide application
stability in cases of delayed control
Resistant cultivars

TMG 803

Susceptible
Resistant cultivars

TMG 801

Susceptible
Resistant cultivars

| Susceptible | BRSGO 7560 | TMG 801 | TMG 803 |
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5. Perspectives for 2009/10
2009/10

- Unusually mild and wet winter;
- *El Niño* Southern Oscillation (ENSO) phenomenon forecast with well distributed rain until the end of December for most soybean region in Brazil;
- ASR started in commercial crops one month before 2008/09 but most of the cases after flowering stage;
- Resistant cultivars are in test in the field

**SBR has shown that no crop season is alike; new challenges appear every year**
Acknowledgements

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