Aerial application strategies for soybean rust control

Ulisses Antuniassi
Sao Paulo State University - Botucatu/SP - Brazil
ulisses@fca.unesp.br
Introduction
Agricultural aviation in Brazil

- 1200 aircrafts: 80% Brazilian built Ipanema
- 264 companies
- 6000 jobs
- Covers 10% of farm land in Brazil:
  7 million ha (17.3 million acres)
- More than 18 million ha (45 million acres) applied every year

Araujo, 2004
Introduction
Application technology: basic information
Droplet size

Volume rate

• Operational characteristics (speed, swath width, flight height, etc.)
• Climate (temperature, RH, wind)
• Drift risk
• Timing
## Performance x drift risk

<table>
<thead>
<tr>
<th>Drift</th>
<th>Penetration</th>
<th>Coverage</th>
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<tbody>
<tr>
<td><strong>Very fine</strong> to <strong>fine</strong> droplets</td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td><strong>Medium</strong> to <strong>coarse</strong> droplets</td>
<td>↓</td>
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Hardi

Ulisses Antuniassi
Application conditions

**Good conditions:**
- Early in the morning, at night;
- Lower temperature, higher RH, average wind

*Smaller droplets and lower volumes*

**Critical conditions:**
- Late in the morning, mid day;
- Higher temperature, lower RH, strong wind

*Bigger droplets and higher volumes*

**Best conditions:**
- Temperature: < 30°C
- RH > 50%
- Wind: from 3 to 10 km/h (1,9 to 6,3 mph)
Adjuvant: oil + emulsifier
Adjuvant

Oil adjuvant: 5 to 20% v/v

• Soybean or cotton oil;
• Used to minimize evaporation of spray droplets
• Helps to improve retention and absorption of fungicides

Emulsifier: 0.25 to 0.35% v/v
Spray solution

Tank mixture:
- Testing every new tank mixture (different formulations);
- Focus on stability of the solution.

Example:

**EC formulation**

1\textsuperscript{st}: Oil
2\textsuperscript{nd}: Emulsifier
3\textsuperscript{rd}: Fungicide
4\textsuperscript{th}: Water

Other formulations may require pre-mixture to the water
Adjuvant: spray quality and droplet size

Silsoe Research Institute

(a) 
(b) 
(c) 

Silsoe Research Institute

VMD, μm

Nozzle size

Silsoe Research Institute

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Adjuvant: drift risk

- Water
- 0.5% surfactant
- 0.5% EC
- EC + Surfactant

Silsoe Research Institute
Management of aerial application
Operation:
- Flight height
- Swath width
- Speed
- Wind direction
Cone nozzles: higher volumes

20 to 50 L/ha (2.2 to 5.5 gpa)
Rotary atomizers: lower volumes

5 to 20 L/ha (0.5 to 2.2 gpa)
Application height

Hydraulic nozzles
Higher volumes
Bigger droplets
Narrower swaths

Rotary atomizers
Lower volumes
Smaller droplets
Wider swaths
Ground or aerial: management decision

• Timing of application

Example:
Preventative treatment for soybean rust

Aerial application (Ipanema):
100 to 250 ha/h (250 to 600 acres/h)
Cost: $ 5.00 to 10.00/ha ($ 2.00 to 4.00/acre)

Ground application (2000-L tank, 65-ft boom):
20 to 30 ha/h (50 to 75 acres/h)
Cost: $ 2.00 to 3.00/ha ($ 0.80 to 1.20/acre)
Ground or aerial: management decision

- Aerial application in the US: typically around 45 L/ha (5 gpa)
- Productivity of an AT502 at different volume rates:

  Lower volume rates in Brazil, Mato Grosso State:

  Example: 0.5 gpa (5 L/ha)

  AT 402 = 900 acres/h
  Ipanema = 600 acres/h

AT502 at 5 gpa = 250 acres/h
Ground or aerial: management decision

- Availability
- Costs
- Knowledge
- Climate conditions
- Damage to the crop (ground application)
Spray technology: performance
Preventative soybean rust control
Fungicide: myclobutanol

Team:
Ulisses R. Antuniassi - UNESP
Tiago V. Camargo - FMT
Edivaldo D. Velini - UNESP
Anderson L. Cavenaghi - UNESP
Zulema N. Figueiredo - UNESP
Maria A. P. O. Bonelli - FMT

Feb/2004
Partners

• Fundação MT
• Dow Agrosciences: Systhane CE (myclobutanil)
• Maggi Group: Ponte de Pedra Farm, Rondonópolis/MT
• CBB: Rotary atomizer Turboaero 88A (discs)
**Methods**

**Soybean:** MT/BR-51 Xingu  
Field: 120 ha (300 acres)  
Plots: 3,2 ha (8 acres)  
7 treatments and 4 replications: control plots for each treatment  
Ground sprayer: Jacto Columbia (2000-L, 55-ft boom)  
Aircraft: Ipanema

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Code</th>
<th>Speed km/h (mph)</th>
<th>Swath/height m (ft)</th>
<th>Spray volume L/ha (gpa)</th>
<th>Droplet size ASAE S572</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ground</td>
<td>XR 11003 (2,5 kPa)</td>
<td>120 XR</td>
<td>10 (6.3)</td>
<td>-</td>
<td>120 (13,2)</td>
</tr>
<tr>
<td>Ground</td>
<td>TXVK 8 (12 kPa)</td>
<td>120 TX</td>
<td>10 (6.3)</td>
<td>-</td>
<td>120 (13,2)</td>
</tr>
<tr>
<td>Aerial</td>
<td>D 10-45 80° (2,1 kPa)</td>
<td>A 30</td>
<td>180 (110)</td>
<td>15 / 3 (45 / 10)</td>
<td>30 (3,3)</td>
</tr>
<tr>
<td>Aerial (*)</td>
<td>Turboaero 88A</td>
<td>BVO 5</td>
<td>180 (110)</td>
<td>20 / 5 (60 / 15)</td>
<td>5 (0.5)</td>
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<td>Aerial (*)</td>
<td>Turboaero 88A</td>
<td>BVO 8</td>
<td>180 (110)</td>
<td>20 / 5 (60 / 15)</td>
<td>8 (0.9)</td>
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<tr>
<td>Aerial (*)</td>
<td>Turboaero 88A</td>
<td>BVO 12</td>
<td>180 (110)</td>
<td>20 / 5 (60 / 15)</td>
<td>12 (1.3)</td>
</tr>
</tbody>
</table>

(*) includes soybean oil (1 L/ha) and emulsifier (0,025 L/ha)
First application (R1): pyraclostrobin + epoxiconazole, Spray technology: aerial, rotary atomizer, fine droplets, 12 L/ha (1.3 gpa)

Second application (spray trial), 21 days after 1\textsuperscript{st} application: myclobutanil
Spray technology according each treatment.
Methods

Temperature: 27 a 31 °C
RH: 75 a 85%
Wind: 5 a 10 km/h (3 to 6 mph)
Methods
Methods

Laboratory:
Results:

• Treated plots: rust control due to the second application. Control plots received only the first application;

• Fungicide deposits: chromatography;

• Rust: % of rust infection reduction compared to the control plots;

• Soybean yield.
  (Considering 3% damaged by the ground sprayer)
Fungicide deposits

- Fungicide deposits even on the lower volume

<table>
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<tr>
<th>Position</th>
<th>Lower leaves</th>
<th>uL/cm²</th>
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<tbody>
<tr>
<td>BVO 5</td>
<td></td>
<td>0,0131</td>
</tr>
<tr>
<td>BVO 8</td>
<td></td>
<td>0,0158</td>
</tr>
<tr>
<td>BVO 12</td>
<td></td>
<td>0,0198</td>
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Upper ➔
Middle ➔
Lower ➔
Fungicide deposits

- Fungicide deposits even on the lower volume

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<td>BVO 12</td>
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**Fungicide deposits**

- % de myclobutanil (Systhane CE) deposited on the plants

![Graph showing fungicide deposits on different plant parts](image)

- Upper leaves
- Middle leaves
- Lower leaves
Fungicide deposits

• % de myclobutanil (Systhane CE) deposited on the plants

Upper leaves

Middle leaves

Lower leaves

%
## myclobutanil: rust control 16 DAT

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<thead>
<tr>
<th>Treatments</th>
<th>Rust (%)</th>
</tr>
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<tbody>
<tr>
<td>120 XR</td>
<td>1.3</td>
</tr>
<tr>
<td>120 TX</td>
<td>0.6</td>
</tr>
<tr>
<td>A 30</td>
<td>1.7</td>
</tr>
<tr>
<td>BVO 5</td>
<td>2.3</td>
</tr>
<tr>
<td>BVO 8</td>
<td>0.8</td>
</tr>
<tr>
<td>BVO 12</td>
<td>0.9</td>
</tr>
<tr>
<td>Control plot</td>
<td>32.5</td>
</tr>
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</table>

![Graph showing % rust reduction for different treatments.](chart.png)
Soybean yield

Soybean yield (bags/ha)

120 XR  120 TX  A 30  BVO 5  BVO 8  BVO 12  Test.
Soybean yield (bags/ha)

120 XR  120 TX  A 30  BVO 5  BVO 8  BVO 12  Test.
Curative soybean rust control

Fungicide: flutriafol

Team:
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Anderson L. Cavenaghi - UNIVAG
Zulema N. Figueiredo - UNEMAT
Maria A. P. O. Bonelli - UNESP
Marcelo Rocha Correa - UNESP
José Luiz de Siqueira - CEFET
Jose Roberto Marques - UNESP

Feb/2005
Partners

• Fundação MT
• Embraer-Neiva: Ipanema
• Cheminova: Impact 125 SC (flutriafol)
• Sementes Petrovina (Farm)
• Micronair/Inglaterra: AU 5000 rotary atomizer
• Agrotec: Micronair dealer/Brazil
• Spectrum/USA: electrostatic system
• Taim Aero Agrícola: Spectrum dealer/Brazil
• Stol/Brazil: Stol ARD rotary disk atomizer
Methods

Field: 102 ha (250 acres)
Plots: 2.8 ha (7 acres)
Soybean: Pioneer 98C81 (6/Nov/04)

Fungicide applications:
1\textsuperscript{st} application: myclobutanil (55 DAS)
Spray tech.: aerial, rotary atomizer, fine droplets, 12 L/ha (1.3 gpa)

2\textsuperscript{nd} application: tebuconazole (13 days after 1\textsuperscript{st} appl.)
Spray tech.: aerial, rotary atomizer, fine droplets, 12 L/ha (1.3 gpa)

3\textsuperscript{rd} application: (trial): flutriafol (25 days after 2\textsuperscript{nd} appl.)
Spray tech.: according to each treatment
Methods

Temperature: 28 a 32 °C
RH: 64 a 71%
Wind: 4 a 11 km/h
## Methods

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<tr>
<th>Treatments</th>
<th>Spray volume</th>
<th>Flutriafol*</th>
<th>Oil**</th>
<th>Emulsifier***</th>
</tr>
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<tr>
<td></td>
<td>L/ha (gpa)</td>
<td>L c.p./ha</td>
<td>L/ha</td>
<td>L/ha</td>
</tr>
<tr>
<td>Micronair (10 L/ha with oil)</td>
<td>10 (1.1)</td>
<td>0.5</td>
<td>1.0</td>
<td>0.375</td>
</tr>
<tr>
<td>Micronair (20 L/ha without oil)</td>
<td>20 (2.2)</td>
<td>0.5</td>
<td>-</td>
<td>-</td>
</tr>
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<td>Stol (10 L/ha with oil)</td>
<td>10 (1.1)</td>
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<tr>
<td>Spectrum (10 L/ha - 71% RH)</td>
<td>10 (1.1)</td>
<td>0.5</td>
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* Impact 125 SC; ** Soybean oil; *** BR 455.

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<td>4 / 18 (12 / 55)</td>
<td>AU 5000</td>
<td>Fine</td>
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<td>Micronair (20 L/ha without oil)</td>
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<td>4 / 16 (12 / 48)</td>
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<tr>
<td>Stol (10 L/ha with oil)</td>
<td>185 (115)</td>
<td>2 / 20 (6 / 60)</td>
<td>Stol ARD</td>
<td>Fine</td>
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Methods

Micronair AU 5000

Spectrum system

Stol ARD
Rust and soybean yield
Results: reduction on rust infection

- Micronair 10 (with oil)
- Micronair 20 (without oil)
- Stol 10 (with oil)
- Stol 20 (with oil)
- Spectrum 10 (71% RH)
- Spectrum 10 (64% RH)

Reduction on rust infection (%)

50 55 60 65 70 75 80 85 90 95 100
Results: soybean yield

- Micronair 10 (with oil)
- Spectrum 10 (71% RH)
- Stol 10 (with oil)
- Stol 20 (with oil)
Thank you!

Ulisses R. Antuniassi
FCA/UNESP - Botucatu/SP - Brazil
ulisses@fca.unesp.br
(00 55 14) 96711604