EVALUATION OF FOLIAGE-APPLIED FERTILIZERS AND FUNGICIDES FOR CONTROLLING SOYBEAN LATE SEASON DISEASES DURING TWO GROWING SEASONS IN TUCUMÁN, ARGENTINA

DE LISI V1, GONZÁLEZ V1, REZNIKOV S1,2, STEGMAYER C A1, HENRIQUEZ D D1, DEVANI M R1 & PLOPER L D1,2

1Estación Experimental Agroindustrial Obispo Colombres, William Cross 3150 (T4101AXC), Las Talitas, Tucumán, Argentina; 2CONICET, Argentina
E-mail: vdelisi@eeaoc.org.ar

Diseases are among the biotic factors that reduce soybean yield in the province of Tucumán, located in north-western Argentina (NWA). Continued monocropping and no-tillage systems, practices widely used at present in soybean production, have been related with the escalation of many of the disease problems that have occurred in recent years, including the ‘late season disease complex’, a combination of various diseases that affect stems, leaves, pods, and seeds, causing premature senescence and lowering yield and seed quality. The main diseases included in this complex are brown spot (Septoria glycines), Cercospora blight and leaf spot (Cercospora kikuchii), and target spot (Corynespora cassiicola). Foliar-applied fungicides are recommended for managing this group of diseases.

Fungicides combined with foliar fertilizers are frequently used in soybean production in NWA. In addition to improving crop nutrition, microelements such as K, Zn, and others, act as elicitors activating plant defense mechanisms, whereas fungicides can prevent or cure fungal infections. Furthermore, biological fertilizers contribute to sustainable production due to their low environmental impact.

To evaluate the use of foliar-applied fungicides and fertilizers for the control of late season diseases, field trials were conducted during the 2010-2011 and 2011-2012 growing seasons at Puesto del Medio, Tucumán, Argentina. Treatments were arranged in a randomized complete block design with four replications. Plots consisted of four 6-m rows, spaced 0.5 m apart (12 m²). The same maturity group VIII cultivar was used during both seasons. The following treatments were evaluated: an untreated control, a commercial fungicide (a strobilurin + trizol mixture) applied at the R3 growth stage, and three foliar fertilizers (a mixture of cytokinin, gibberelic acid, and indole-3-butyric acid + CaB; potassium phosphite; and zinc phosphite), applied at different growth stages (R1, R3 or R1+R3) with or without fungicide. Treatments were evaluated in terms of brown spot and Cercospora blight and leaf spot severity. Yield (kg/ha) and seed size (1,000 seed weight) were also determined.

In the 2010-2011 growing season, environmental conditions were favourable for both crop growth and disease development. None of the treatments differed significantly from the untreated control in Cercospora blight severity, but most of the treatments with fertilizers and fungicides showed less brown spot severity than the untreated control. No additional benefits in disease control were observed when adding fertilizers to the fungicide. However, the addition of potassium phosphate to the fungicide at R3 increased yield significantly. In the 2011-2012 season, environmental conditions were very unfavourable for crop growth. Three fertilizer treatments decreased Cercospora blight severity significantly, and nearly all of them reduced brown spot severity in comparison to the untreated control, but there were no differences with the treatment that only included the fungicide. Only the fungicide treatment led to significantly higher yields than those of the untreated control.
Evaluation of foliage-applied fertilizers and fungicides for controlling soybean late season diseases during two growing seasons in Tucumán, Argentina

Vicente DE Lisi, Victoria González, Sebastián Reznikov Carlos A. Stegmayr, Diego D. Henriquez, Mario R. Devani and L. Daniel Ploper
Northwestern Argentina

22° - 29° Latitude South
63° - 68° Longitude West

2011/2012

<table>
<thead>
<tr>
<th>Province</th>
<th>Area (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salta</td>
<td>608,620</td>
</tr>
<tr>
<td>Tucumán</td>
<td>231,320</td>
</tr>
<tr>
<td>W of Santiago del Estero</td>
<td>106,360</td>
</tr>
<tr>
<td>SE of Catamarca</td>
<td>37,000</td>
</tr>
<tr>
<td>Jujuy</td>
<td>12,485</td>
</tr>
<tr>
<td>NWA</td>
<td>995,785</td>
</tr>
</tbody>
</table>
Tucumán 2011-2012

Soybean 231,220 ha
Maize 49,540 ha
Soybean diseases

- Biotic factors that reduce production efficiency
- Continued monocropping and no-tillage systems
Late season disease complex

- Brown spot
- Downy mildew
- Frogeye leaf spot
- Target spot
- Anthracnose
- Bacterial blight
- Cercospora leaf spot
- Pod and stem blight
- Phomopsis seed rot
Asian soybean rust – *Phakopsora pachyrhizi*
Disease management strategies

Integrated management programs are recommended, with special attention to the economic aspects of crop production, considering that prevention rather than curative treatments are preferable.

Specific strategies to consider include various approaches to disease control:

- Exclusion and surveillance
- Cultural practices
- Biological methods
- Chemical control
Since the late 1990s, the Estación Experimental Agroindustrial “Obispo Colombres” (EEAOC) has been conducting numerous experiments of chemical control of foliar diseases.
Locations of field experiments

Puesto del Medio

San Agustín
Evaluation of foliar fungicides for the control of soybean late season diseases and rust in Tucumán, Argentina

- Location: San Agustín, Tucuman, Argentina
Cercospora blight and leaf spot (*Cercospora kikuchii*)

- **Location:** San Agustín, Tucuman, Argentina

![Bar graph showing severity of Cercospora blight and leaf spot from 2008/2009 to 2011/2012]
Brown spot 
(*Septoria glycines*)

- **Location**: San Agustín, Tucuman, Argentina
Evaluation of foliar fungicides for the control of soybean late season diseases and rust in Tucumán, Argentina

• Location: Puesto del Medio, Tucuman, Argentina
Cercospora blight and leaf spot, brown spot and rust in Puesto del Medio, Tucumán

Location: Puesto del Medio, Tucuman, Argentina
Foliar fungicides + foliar fertilizers

Fungicides combined with foliar fertilizers have become frequently used in soybean production in NWA.

Foliar fertilizers improve crop nutrition; microelements, such as K, Zn, and others, act as elicitors activating defense mechanisms in plants, whereas fungicides can prevent or cure fungal infections.

Furthermore, biological fertilizers contribute to sustainable production due to their low environmental impact.
Foliage-applied fertilizers

- The application of foliar nutrients in soybean is a practice whose study has intensified in recent years.

- Foliar fertilization with N, P, K and S during the seed-filling period are intended to avoid the depletion of these nutrients in the leaves and the resulting reduction in photosynthetic rate during this period due to poor nutrient uptake from the soil and translocation of these elements from the leaves to the developing seeds.

- The literature mentions significant yield increases with two to four sprayings on different soybean cultivars at different experimental sites between developmental stages R5 and R7.
Foliage-applied fertilizers

• Phosphites foliar fertilizers consist of phosphite ion combined primarily with micronutrients.

• The phosphite ion acts on the hormonal system and promotes the synthesis of phytoalexins, metabolites synthesized in response to microbial infections, chemicals, mechanical damage or stress.

• Moreover, the phosphite fertilizer has been attributed a property of synergizing with fungicides, through an expansion of its systemic effect.

• Micronutrients are represented by cations such as Zn and Cu, that act as catalysts in various enzymatic processes.
In Argentina, Carmona et al. evaluated in the 2004-2005 season the efficiency of the following treatments for the control of soybean late season diseases.

1) 70% potassium phosphite 0.5 l/ha, 2) 70% potassium phosphite, 1 l/ha, 3) 6.8% nitrogen and 9.3% phosphorus, 3 l/ha; 4) Azoxystrobin + cyproconazole (Amistar Xtra) + mineral oil (Nimbus), 300 + 500 cc/ha, 5) Untreated control. Both fertilizers and fungicides were applied at R5.

The lower value of severity was recorded in the fungicide treatment, differing statistically significantly from the control and the other treatments ($p <0.05$). The only treatment that showed statistically significant differences in yield was the mixture of fungicides ($p <0.05$).
Objective

To evaluate the use of foliage-applied fungicides and fertilizers in the control of late season diseases, field trials were conducted during the 2010-2011 and 2011-2012 growing seasons at Puesto del Medio, Tucumán, Argentina.

The main diseases evaluated in this study were brown spot (*Septoria glycines*) and Cercospora blight and leaf spot (*Cercospora kikuchii*).
Brown spot
Cercospora blight and leaf spot (*Cercospora kikuchii*)
Purple seed stain

*Cercospora kikuchii*
Materials and Methods
Materials and methods

- Field experiments
- Location:
  - Puesto del Medio, Tucumán, Argentina

- Fields had been cropped previously to soybean
- Fungicide and fertilizers in variable numbers were evaluated.
- Rates used were those recommended by the manufacturers.
- Treatments were arranged in a randomized complete block with four replications. Plots consisted of four 6-m rows, spaced 0.5 m apart (12 m²).
Materials and methods

- A maturity group VIII cultivar was used both seasons.
- The following treatments were evaluated: an untreated control, a commercial fungicide (mixture of strobilurin + triazol) applied at the R3 growth stage, and three foliar fertilizers (a mixture of cytokinin, gibberellic acid, and indole-3-butyric acid + CaB; potassium phosphite; and zinc phosphite), applied at different moments (R1, R3 or R1+R3) with or without fungicide.
- Treatments were evaluated for severity of brown spot and Cercospora blight, yield (kg/ha) and seed size (1,000 seed weight).
## Fertilizers and fungicides products and rates evaluated in the field experiment

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Rate (cc/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R1</td>
</tr>
<tr>
<td>1- Control</td>
<td>---</td>
</tr>
<tr>
<td>2- Fungicide*</td>
<td>---</td>
</tr>
<tr>
<td>3- Potassium phosphite</td>
<td>1000</td>
</tr>
<tr>
<td>4- Potassium phosphite Fungicide</td>
<td>1000</td>
</tr>
<tr>
<td>5- Potassium phosphite + fungicide</td>
<td>---</td>
</tr>
<tr>
<td>6- Zinc phosphite Zinc phosphite + fungicide</td>
<td>1000</td>
</tr>
<tr>
<td>7- Zinc phosphite + fungicide</td>
<td>---</td>
</tr>
<tr>
<td>8- Mixture of cytokinin, gibberellic acid, and indole 3 - butyric acid + CaB</td>
<td>300 + 3000</td>
</tr>
<tr>
<td>9- Mixture of cytokinin, gibberellic acid, and indole 3 - butyric acid + CaB</td>
<td>300 + 3000</td>
</tr>
</tbody>
</table>

* Fungicide: mixture of strobilurin + triazol (Opera / BASF)
Fertilizer and fungicide application in the field experiments
Results
### Rainfall 2010-2011 and 2011-2012 seasons

<table>
<thead>
<tr>
<th>Growing seasons</th>
<th>Dec</th>
<th>Jan</th>
<th>Feb</th>
<th>March</th>
<th>April</th>
<th>Dec-April</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010-2011</td>
<td>150</td>
<td>414</td>
<td>280</td>
<td>92</td>
<td>38</td>
<td>974</td>
</tr>
<tr>
<td>2011-2012</td>
<td>103</td>
<td>72</td>
<td>42</td>
<td>57</td>
<td>51</td>
<td>325</td>
</tr>
<tr>
<td>Average</td>
<td>112</td>
<td>161</td>
<td>136</td>
<td>126</td>
<td>44</td>
<td>579</td>
</tr>
</tbody>
</table>
2010/2011
Effect of treatments on the severity of brown spot (*Septoria glycines*) and Cercospora blight and leaf spot (*Cercospora kikuchii*)

*Numbers followed by the same letter are not significantly different $P=0.05$) by LSD’s multiple range test
Weight of 1000 soybean seeds (g)

*Numbers followed by the same letter are not significantly different $P=0.05$ by LSD’s multiple range test*
Yield (kg/ha)

*Numbers followed by the same letter are not significantly different \( P=0.05 \) by LSD’s multiple range test.
2011/2012
Effect of treatments on severity of brown spot (*Septoria glycines*) and Cercospora blight and leaf spot (*Cercospora kikuchii*)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Brown spot</th>
<th>Cercospora blight and leaf spot</th>
</tr>
</thead>
<tbody>
<tr>
<td>1- Control</td>
<td>17.5</td>
<td>7.5</td>
</tr>
<tr>
<td>2- Fungicide (R3)</td>
<td>7.5</td>
<td>7.5</td>
</tr>
<tr>
<td>3- Potassium phosphite (R1 + R3)</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>4- Potassium phosphite (R1) + fungicide (R3)</td>
<td>7.5</td>
<td>7.5</td>
</tr>
<tr>
<td>5- Potassium phosphite + fungicide (R3)</td>
<td>7.5</td>
<td>7.5</td>
</tr>
<tr>
<td>6- Zinc phosphite (R1) + fungicide (R3)</td>
<td>12.5</td>
<td>7.5</td>
</tr>
<tr>
<td>7- Zinc phosphite + fungicide (R3)</td>
<td>7.5</td>
<td>7.5</td>
</tr>
<tr>
<td>8- Mixture of cytokinin, gibberellic acid, and indole-3-butyric acid + CaB (R1)</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>9- Mixture of cytokinin, gibberellic acid, and indole-3-butyric acid + CaB (R1) + fungicide (R3)</td>
<td>6.5</td>
<td>7.5</td>
</tr>
</tbody>
</table>

*Numbers followed by the same letter are not significantly different $P=0.05$ by LSD`s multiple range test*
Weight of 1000 soybean seeds (g)

*Numbers followed by the same letter are not significantly different $P=0.05$) by LSD’s multiple range test.
Yield (kg/ha)

*Numbers followed by the same letter are not significantly different $P=0.05$ by LSD’s multiple range test*
Conclusions
In the 2010/2011 growing season, environmental conditions were favorable for both crop growth and disease development.

None of the treatments differed significantly from the untreated control for Cercospora blight severity, but most of the treatments with fertilizers and fungicides had less brown spot severity than the untreated control.

No additional benefits in disease control were observed by the addition of fertilizers to the fungicide. However, the addition of potassium phosphite to the fungicide at R3 increased significantly the yield.
In the 2011-2012 season, environmental conditions were very unfavorable for crop growth.

Three fertilizers treatments decreased significantly Cercospora blight severity and nearly all reduced brown spot severity in comparison with the untreated control, but there were no differences with the treatment that only included the fungicide.

Only the fungicide treatment had significantly higher yields than the untreated control.
Foliar fertilizers and fungicides can be a useful tool in soybean production, but they must be used with caution. As seen in this study, foliar fertilizers + fungicides do not always give significant yield increases. This lack of effectiveness may be due to our inability to predict when and how severe foliar diseases will be in a particular year.

Before using this strategy of management, farmers should considerer: how severe foliar diseases have been in past years, and also other aspects such as cropping history, type of irrigation, rainfall, tillage and yield potential.
Thank you – Baie dankie

www.eeaoc.org.ar

Tucumán - Argentina