

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 S^{1,2}, STEGMAYER C A¹, HENRIQUEZ D D¹, DEVANI M R¹ & PLOPER L D^{1,2}

¹*Estación Experimental Agroindustrial Obispo Colombres, William Cross 3150 (T4101AXC), Las Talitas, Tucumán, Argentina;* ²*CONICET, 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, gibberellic 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 phosphite 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 GONZALEZ, Sebastián REZNIKOV Carlos A. STEGMAYER, Diego D. HENRIQUEZ, Mario R. DEVANI and
L. Daniel PLOPER



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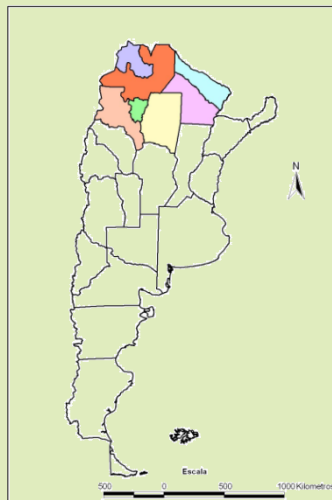




Northwestern Argentina

22 - 29° Latitude South

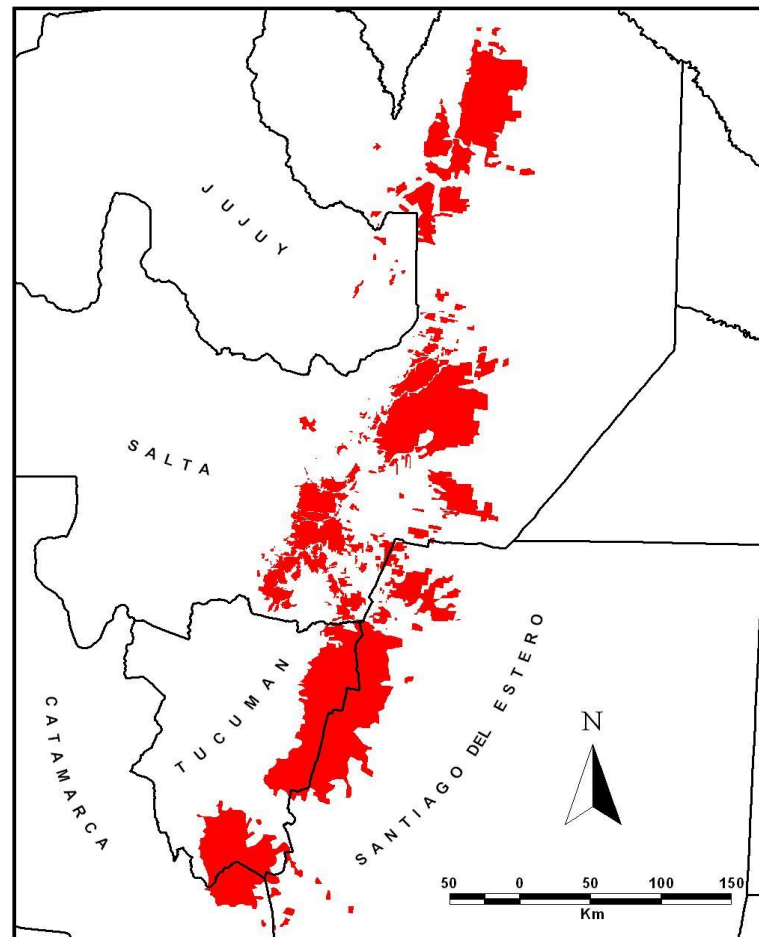
63 - 68° Longitud West



2011/2012

Province	Area (ha)
Salta	608,620
Tucumán	231,320
W of Santiago del Estero	106,360
SE of Catamarca	37,000
Jujuy	12,485
NWA	995,785

República Argentina: Área granera del NOA



Estación Experimental Agroindustrial
"Obispo Colombres"

Sección Sensores Remotos y SIG

Elaboración: Ing. Agr. Carmina Fandos, Lic. Federico J. Soria -
Junio de 2010

REFERENCIAS

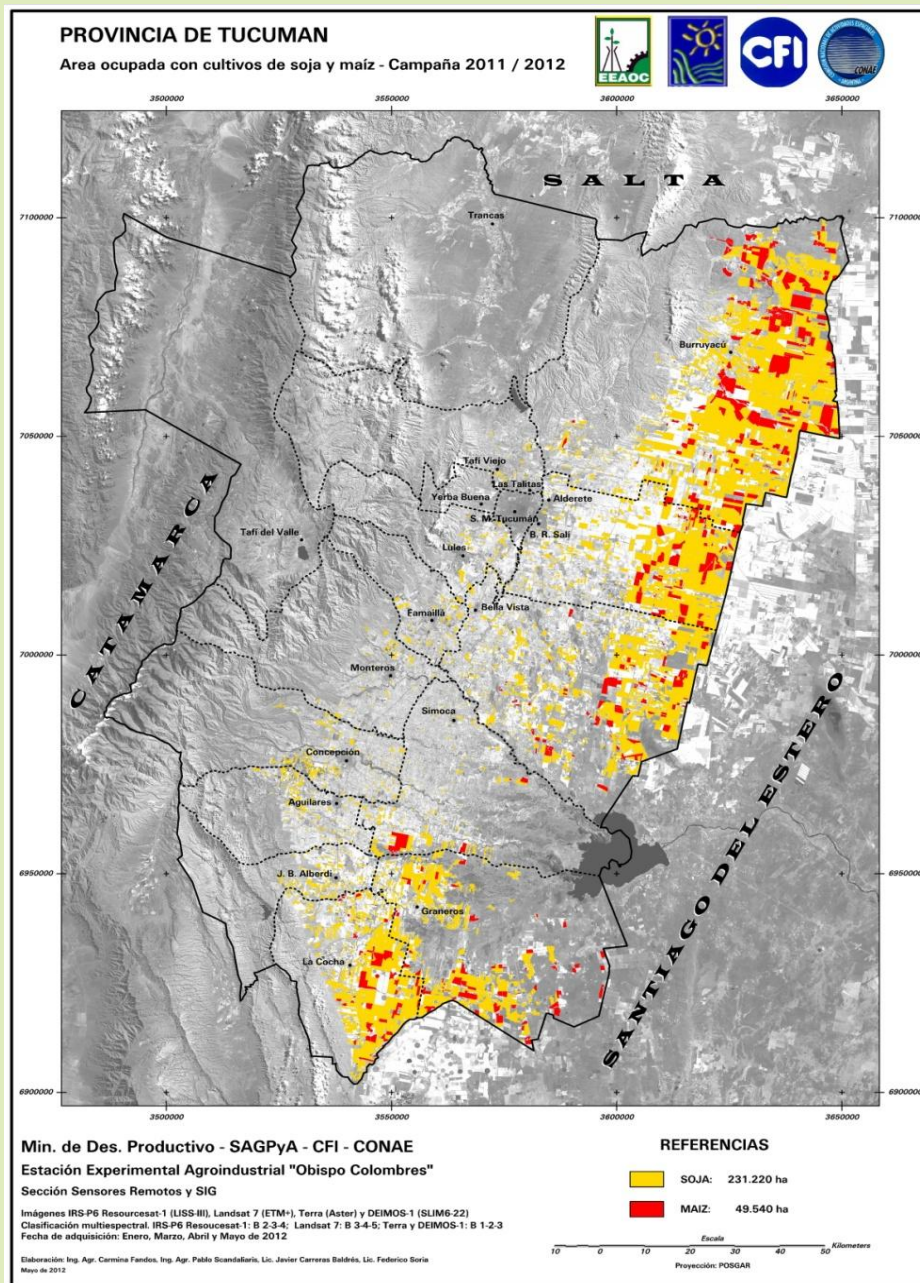
— Limites políticos provinciales

■ Área granera del NOA



Tucumán 2011-2012

Soybean 231,220 ha
Maize 49,540 ha

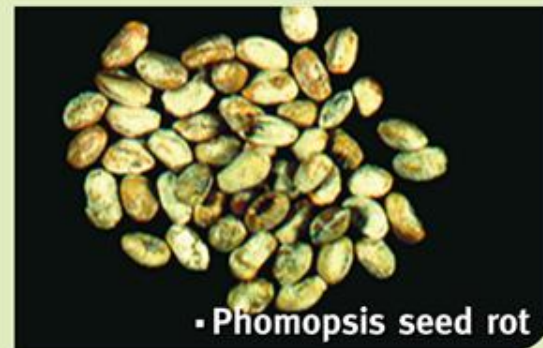
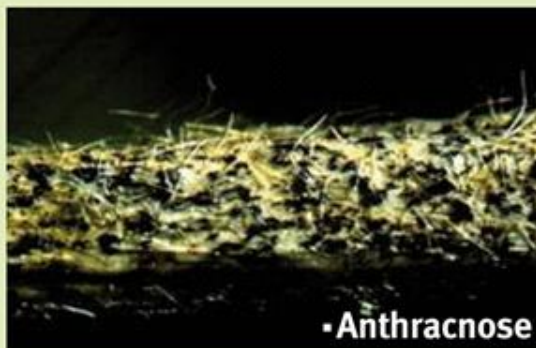
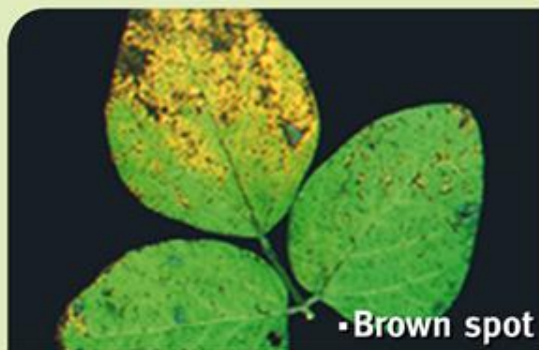


Soybean diseases

- Biotic factors that reduce production efficiency
- Continued monocropping and no-tillage systems



Late season disease complex





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**

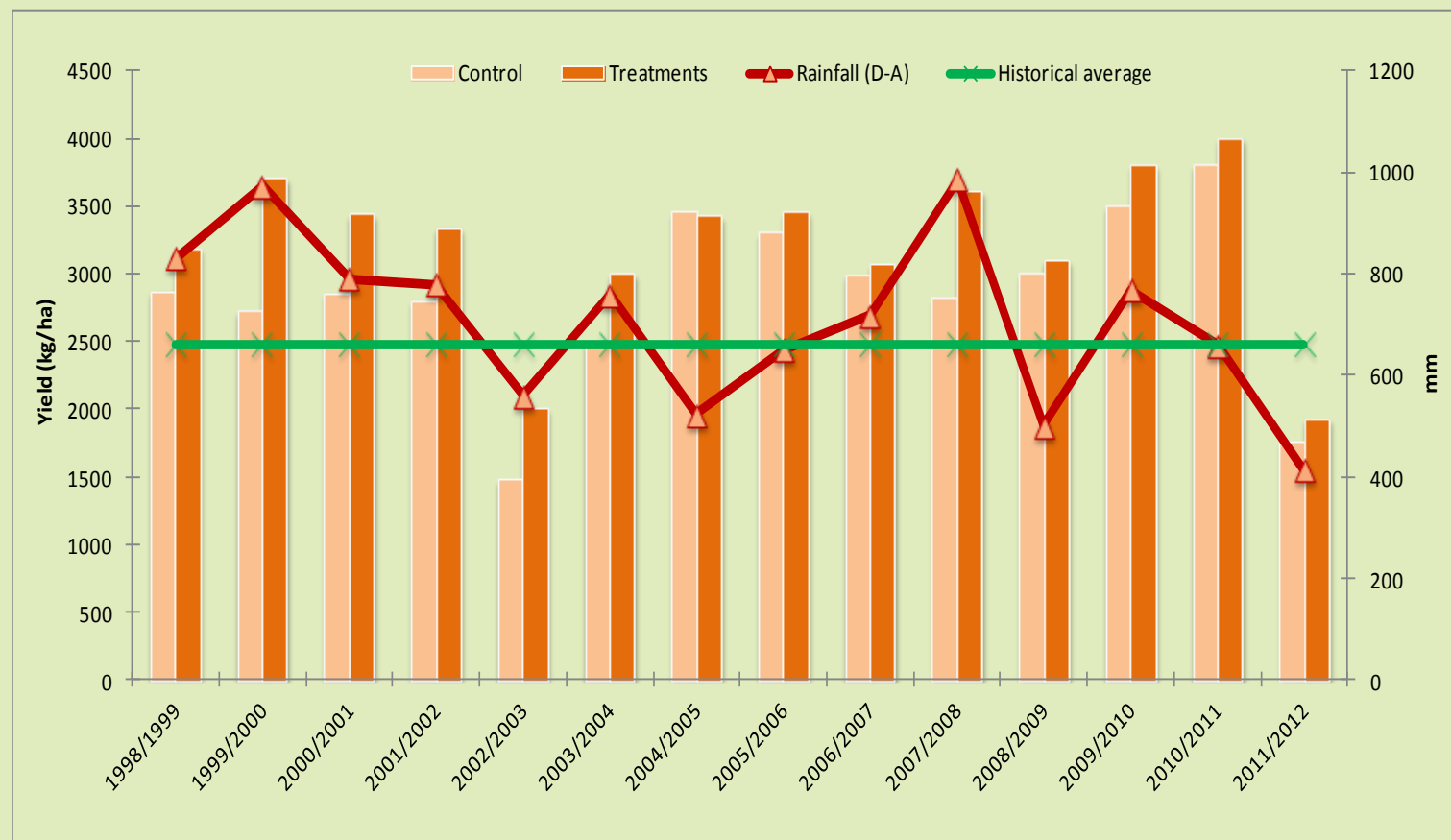




Locations of field experiments



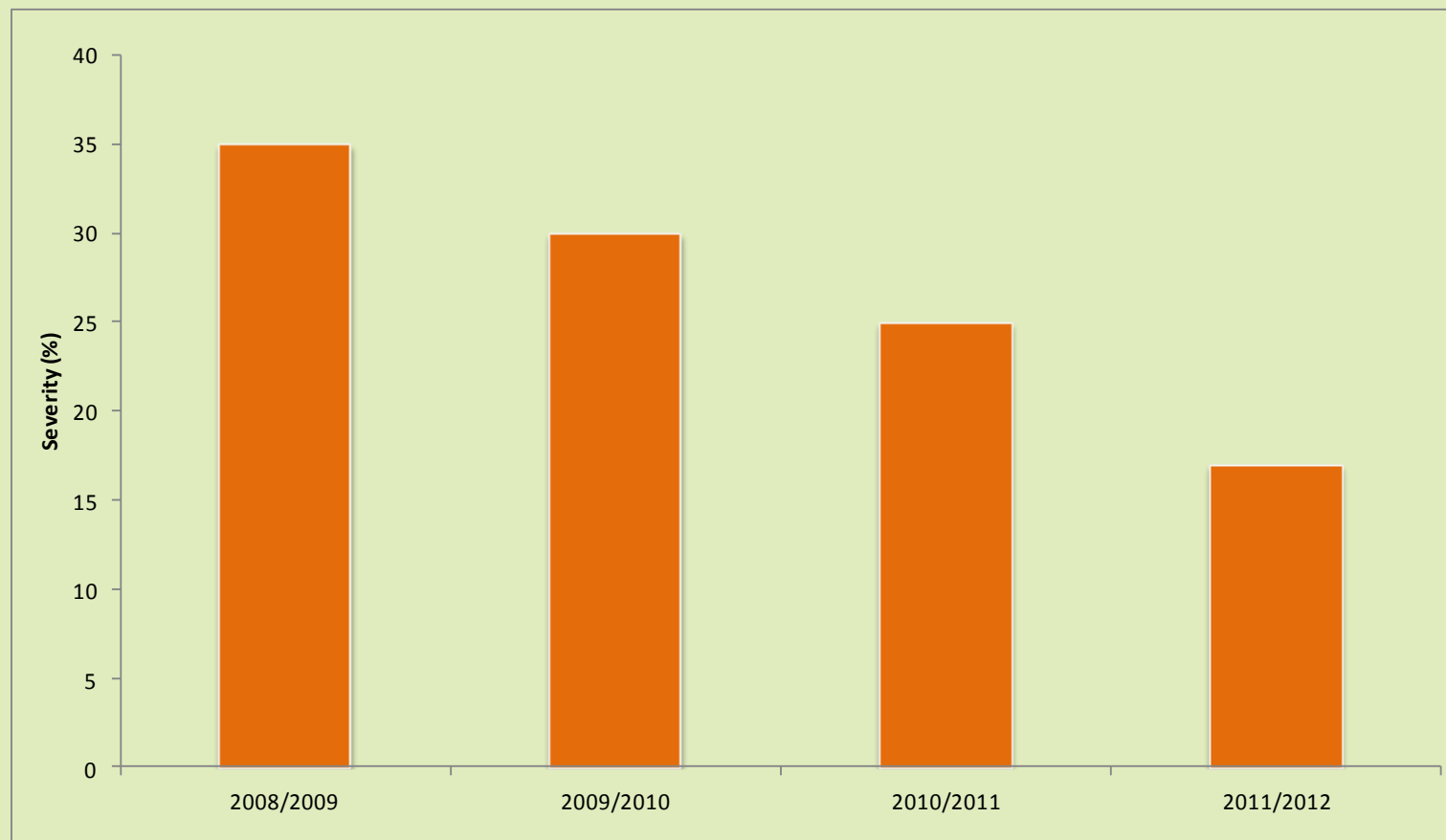
Evaluation of foliar fungicides for the control of soybean late season diseases and rust in Tucumán, Argentina



•Location: San Agustín, Tucuman, Argentina



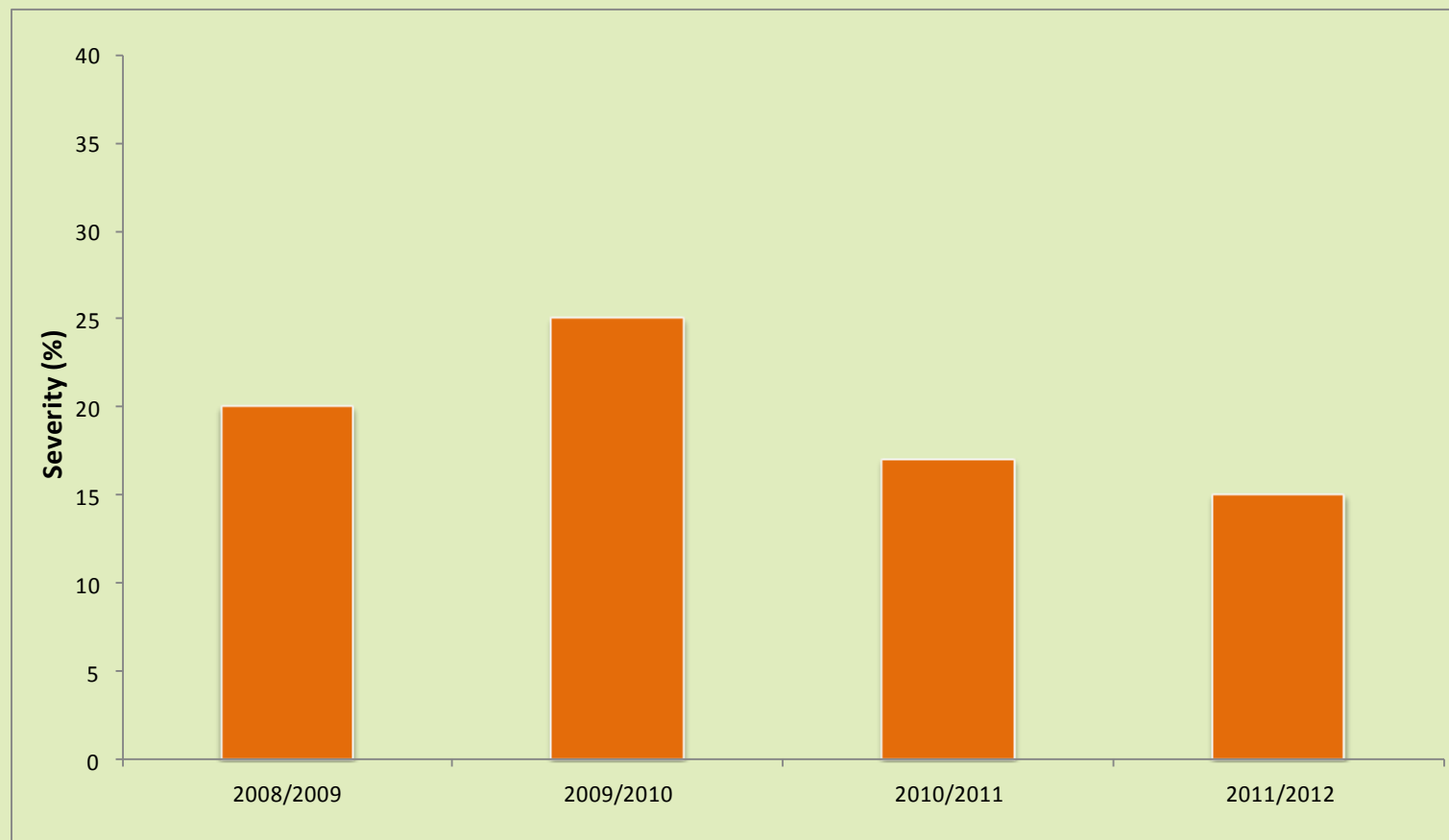
Cercospora blight and leaf spot (*Cercospora kikuchii*)



•Location: San Agustín, Tucuman, Argentina



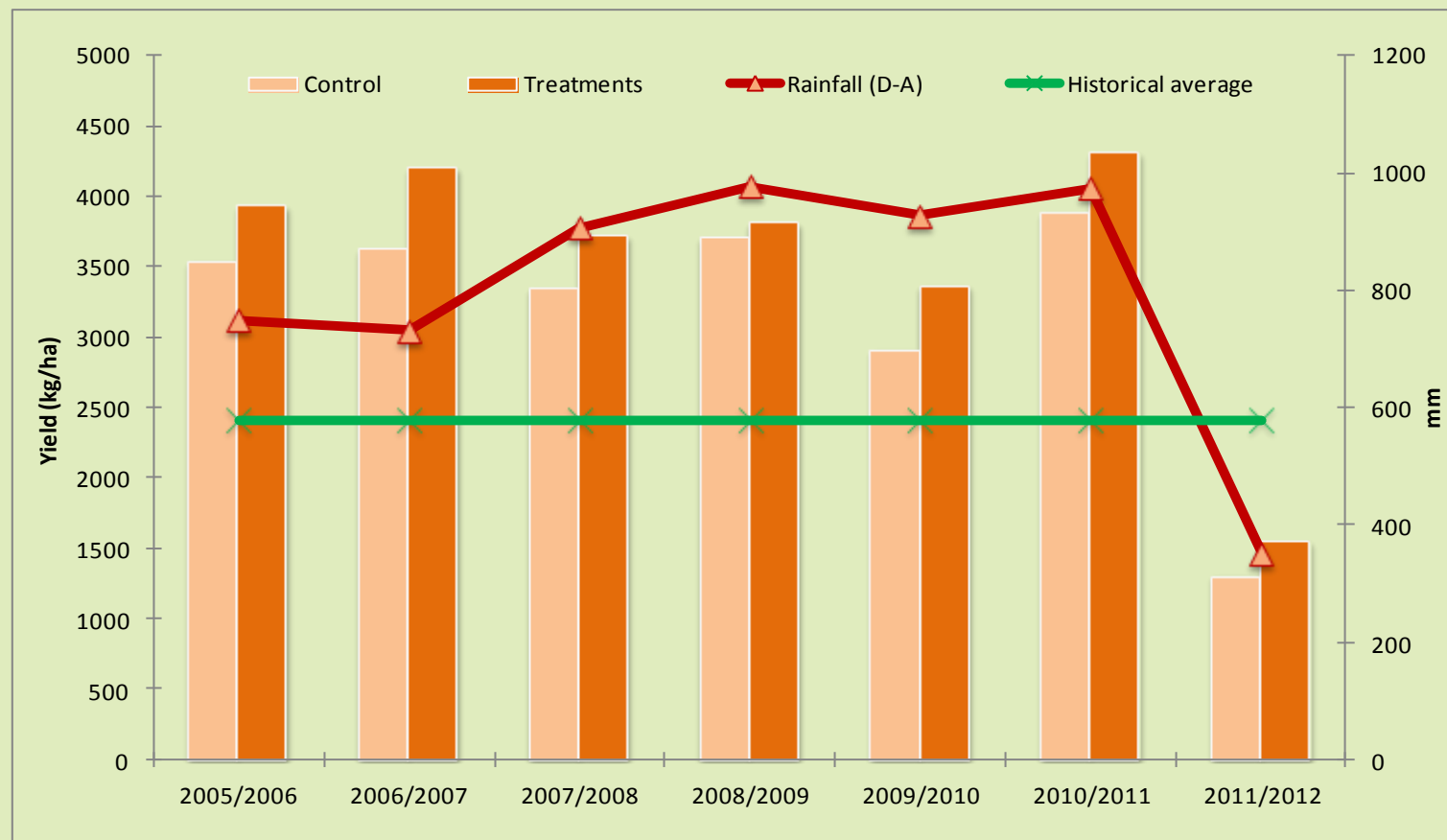
Brown spot (*Septoria glycines*)



•Location: San Agustín, Tucuman, Argentina



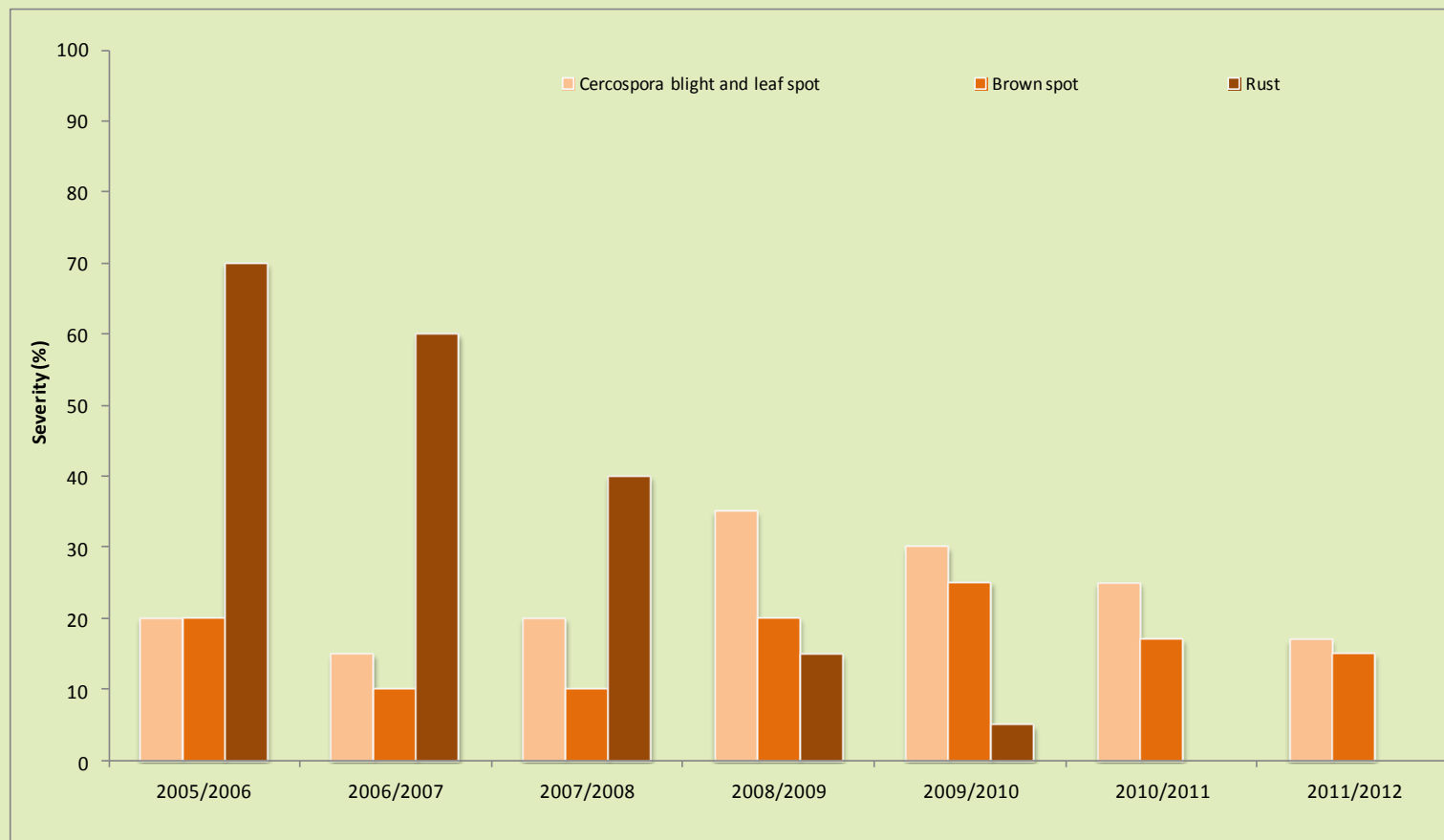
Evaluation of foliar fungicides for the control of soybean late season diseases and rust in Tucumán, Argentina



•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.**



Background



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 ($p < 0.05$).

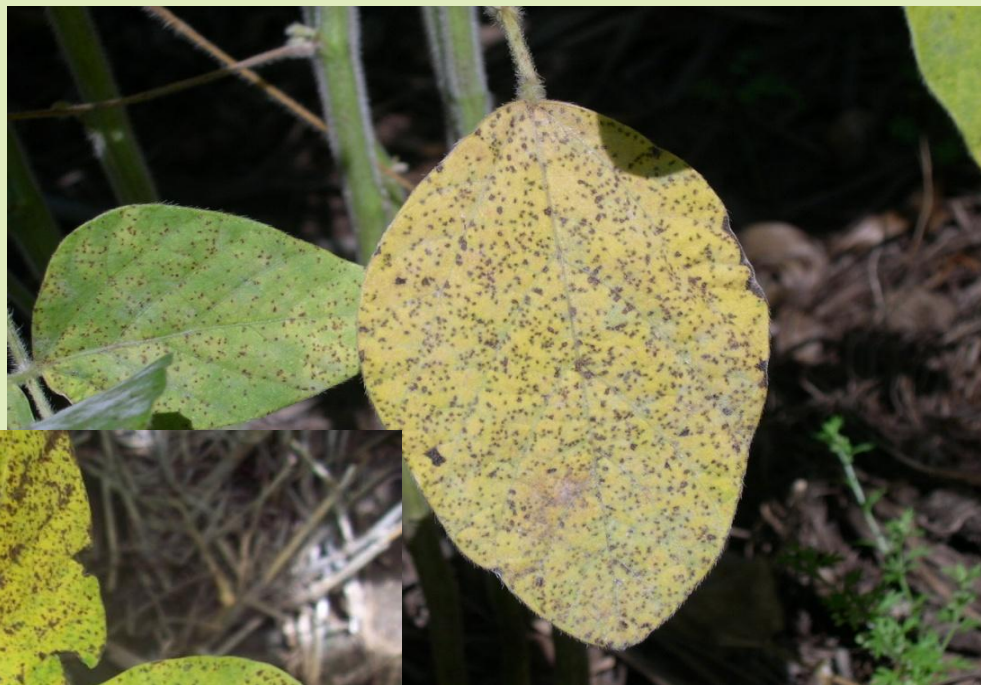


Objective

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

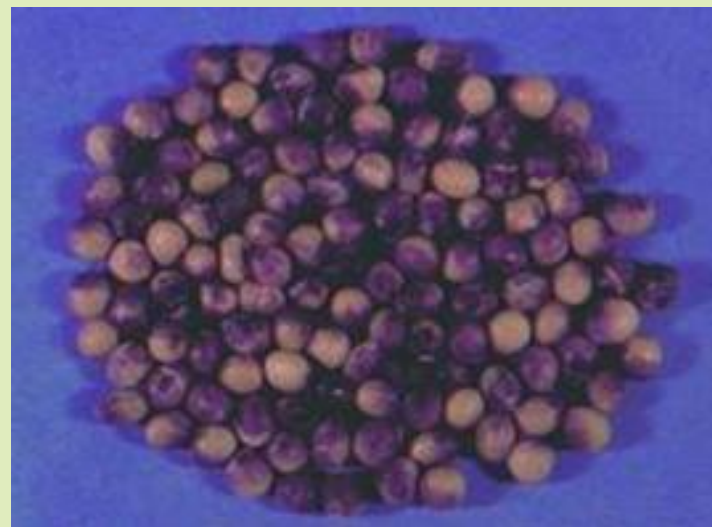


Cercospora blight and leaf spot (*Cercospora kikuchii*)



Purple seed stain

Cercospora kikuchii



The background of the slide is a photograph of a lush green field, possibly a tobacco field, with rows of plants stretching into the distance. Overlaid on this image are two large, white, stylized brackets. The left bracket is positioned on the left side of the slide, and the right bracket is on the right side. They are both oriented vertically, with the top of the brackets pointing towards the top of the slide and the bottom of the brackets pointing towards the bottom. The text "Materials and Methods" is centered between the two brackets.

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

Treatments	Rate (cc/ha)	
	R1	R3
1- Control	---	---
2- Fungicide*	---	500
3- Potassium phosphite	1000	1000
4- Potassium phosphite Fungicide	1000	500
5- Potassium phosphite + fungicide	---	1000 + 500
6- Zinc phosphite Zinc phosphite + fungicide	1000	1000 + 500
7- Zinc phosphite + fungicide	---	1000 + 500
8- Mixture of cytokinin, gibberellic acid, and indole 3 – butyric acid + CaB	300 + 3000	---
9- Mixture of cytokinin, gibberellic acid, and indole 3 - butyric acid + CaB Fungicide	300 + 3000	500

* Fungicide: mixture of strobilurin + triazol (Opera / BASF)

Fertilizer and fungicide application in the field experiments





Results



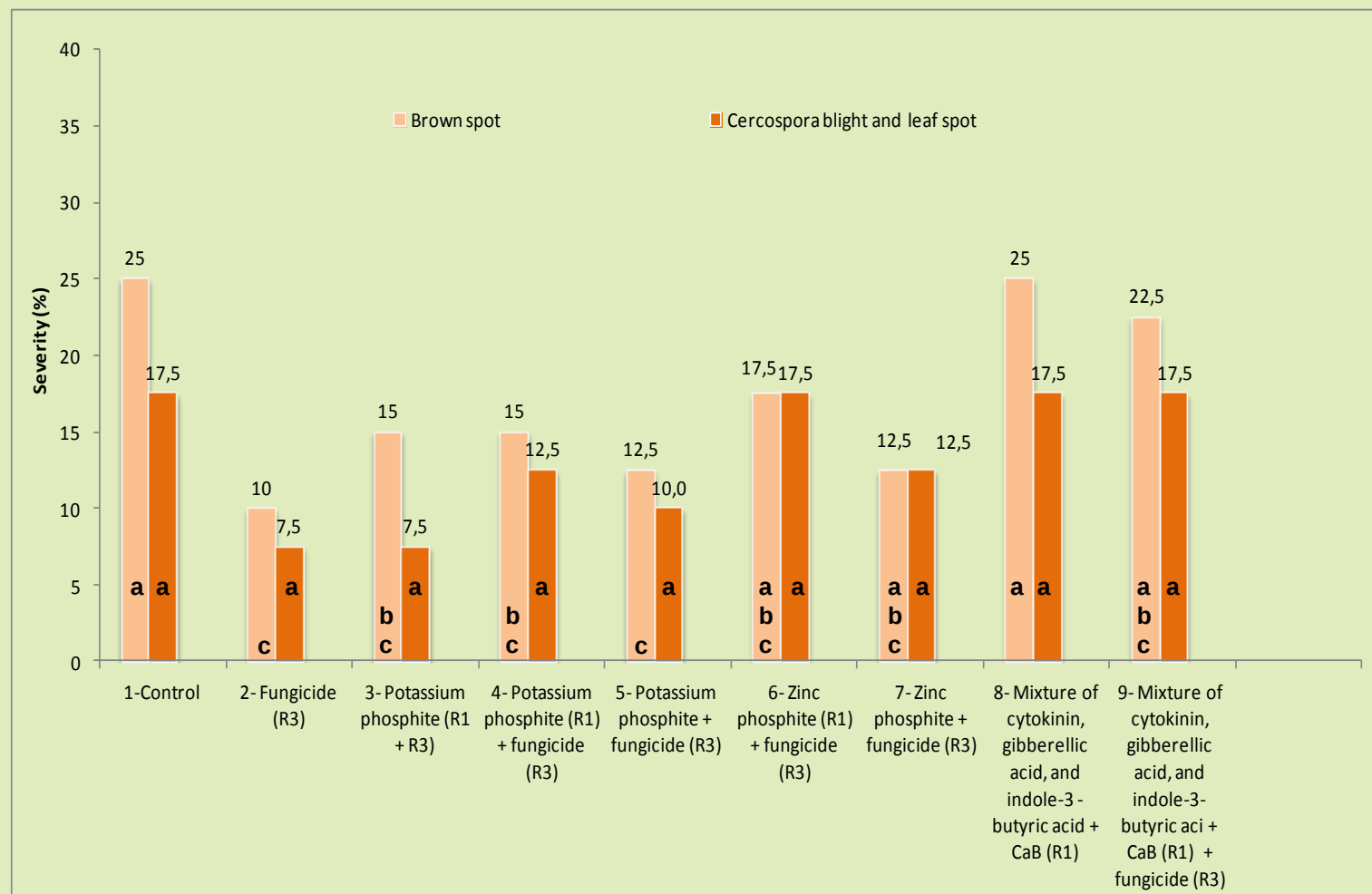
Rainfall 2010-2011 and 2011-2012 seasons

Growing seasons	Dec	Jan	Feb	March	April	Dec- April
2010-2011	150	414	280	92	38	974
2011-2012	103	72	42	57	51	325
Average	112	161	136	126	44	579



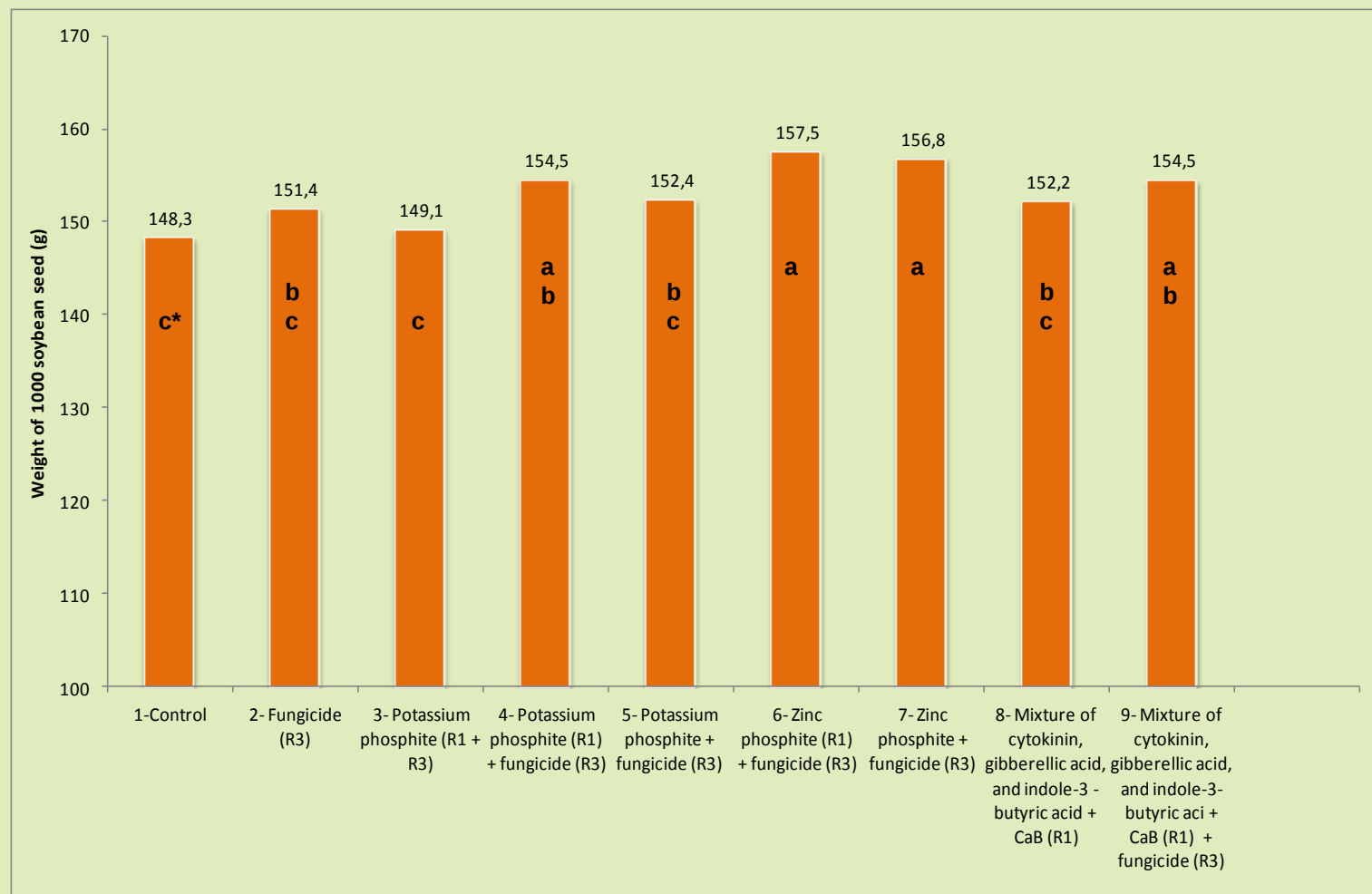
2010/2011

Effect of treatments on the severity of brown spot (*Septoria glycines*) and Cercospora blight and leaf spot (*Cercospora kikuchii*)



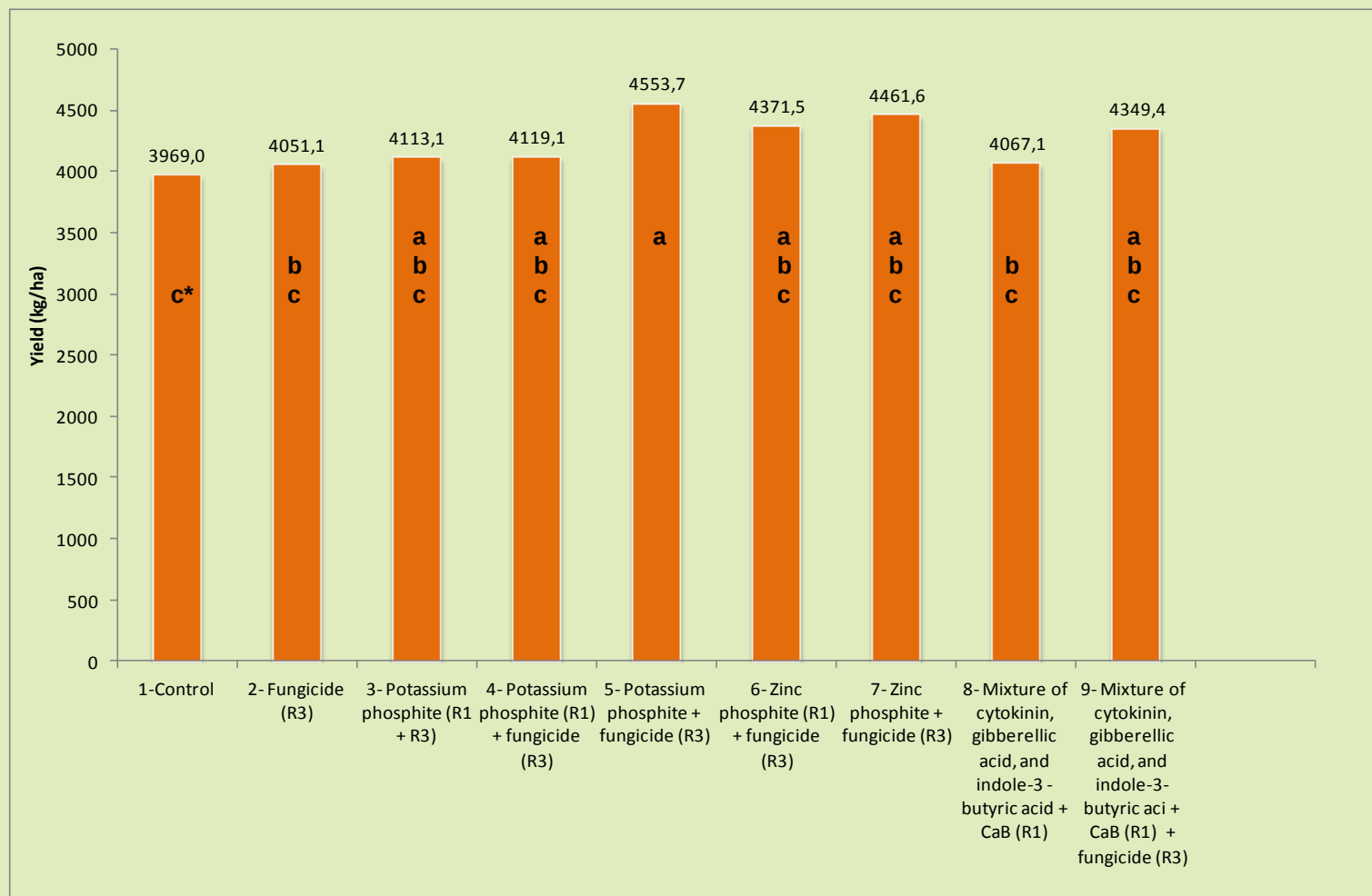
*Numbers followed by the same letter are not significantly different $P=0.05$) by LSD's multiple range test

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)

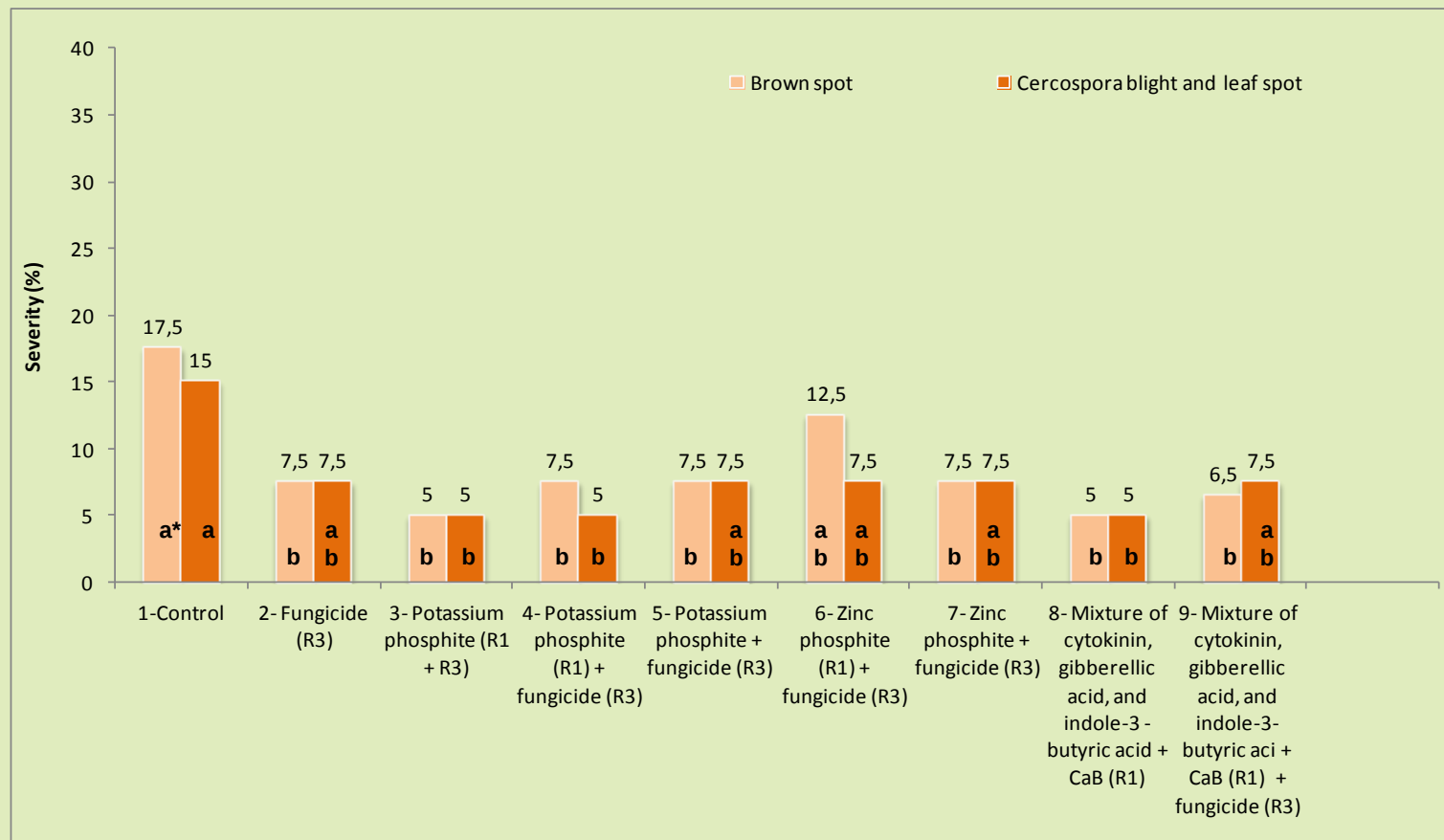


*Numbers followed by the same letter are not significantly different $P=0.05$) by LSD's multiple range test



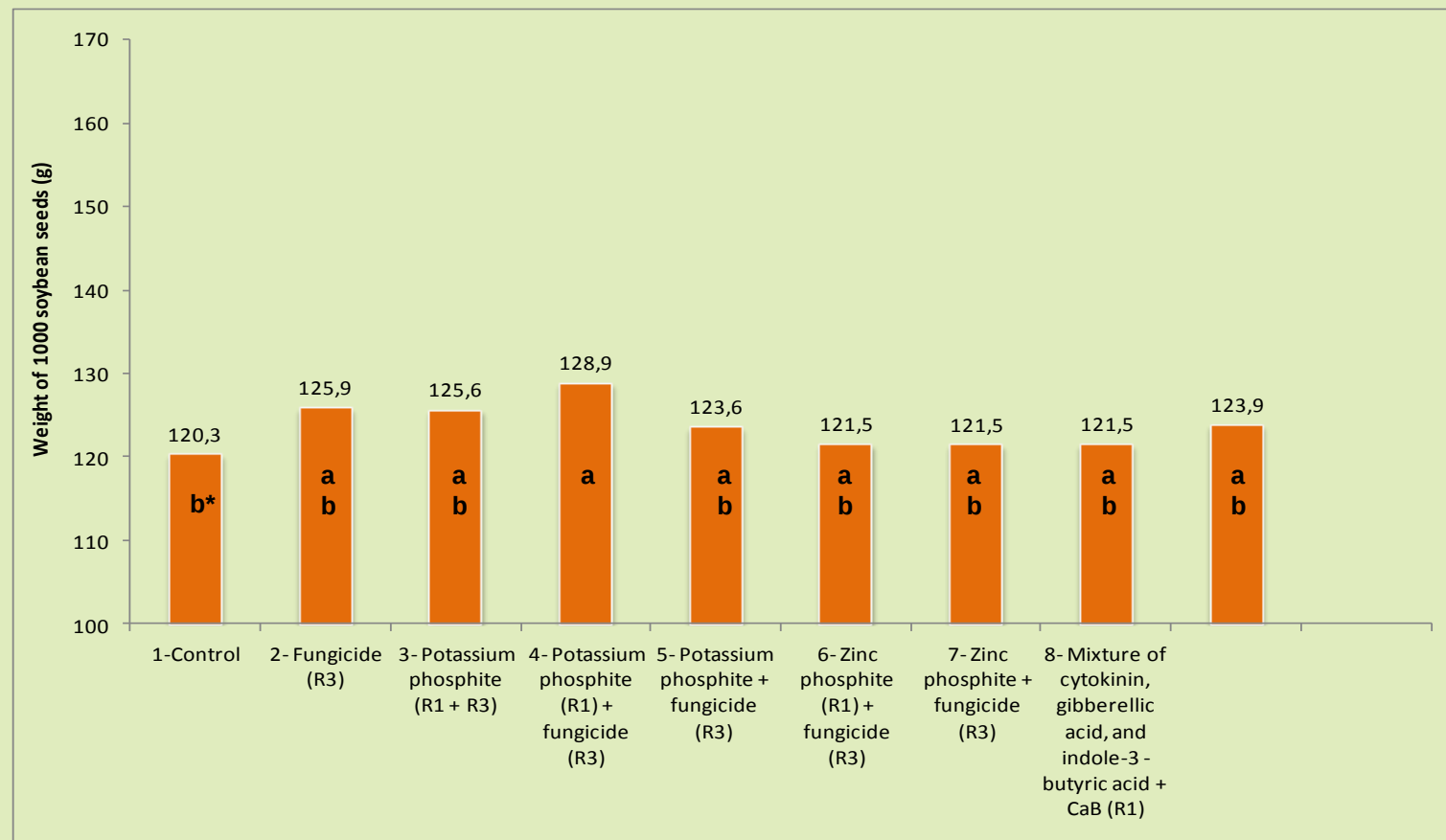
2011/2012

Effect of treatments on severity of brown spot (*Septoria glycines*) and Cercospora blight and leaf spot (*Cercospora kikuchii*)



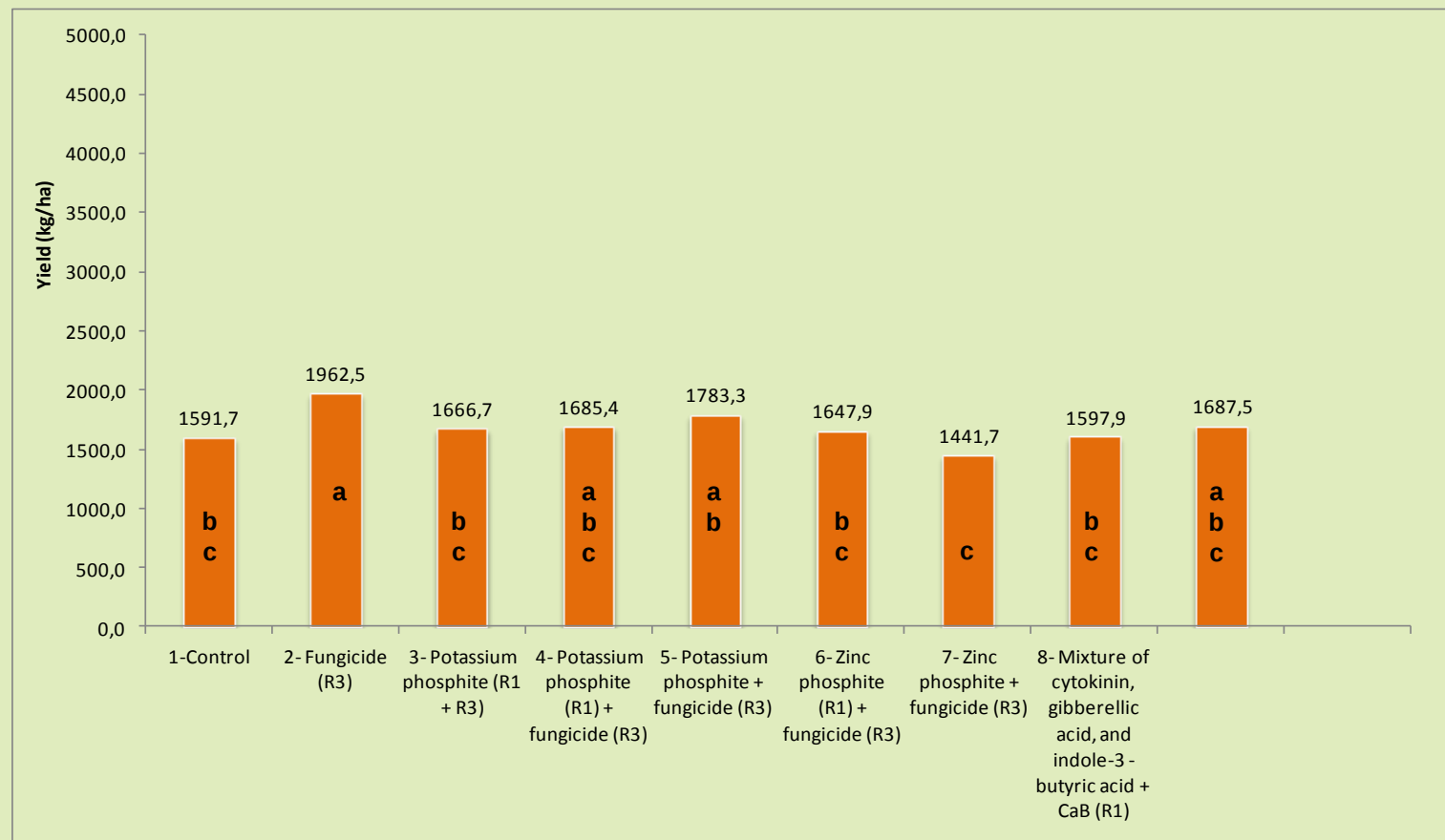
*Numbers followed by the same letter are not significantly different $P=0.05$) by LSD's multiple range test

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



Conclusions (I)

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.



Conclusions (II)

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.



Conclusions (III)

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 consider: 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

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