

Recent advances of the influence of foliar diseases, and their control by fungicides, on breadmaking quality in Argentinean wheat cultivars

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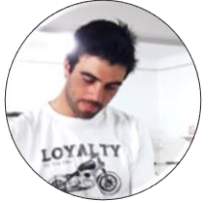
Team



Dr. Ana Carolina Castro
(Wheat Quality)



MSc. Pablo Eduardo Campos
(Plant Pathology)



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(Plant Pathology)



Dr. Guillermo Sebastián Gerard
(Wheat Breeder)

Dr. Silvina Inés Golik
(Professor, UNLP)



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(Wheat Physiology)



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(Professor, UNLP)



Breeders

*ACA, BioINTA, Buck, Klein,
Nidera, Sursem*

Fundings



Consejo Nacional de
Investigaciones Científicas
y Técnicas, Argentina



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Agrarias y Forestales,
UNLP, Argentina

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Agencia Nacional de
Promociones Científicas y
Técnicas, Argentina

Campodónico Mill

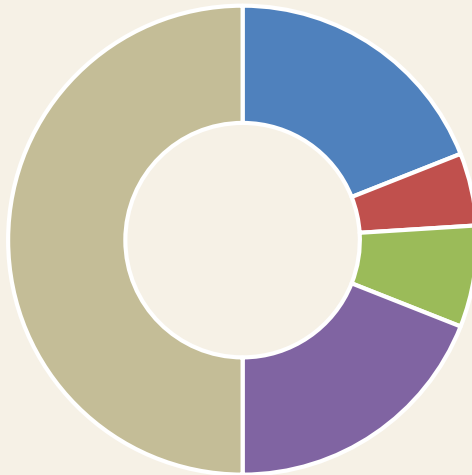


Molino Campodónico

Importance

One of the most important crops in the world

Contributes with calories in the human diet 



- Wheat 19 %
- Corn 5 %
- Sugar 7 %
- Rice 19 %
- Others 50 %

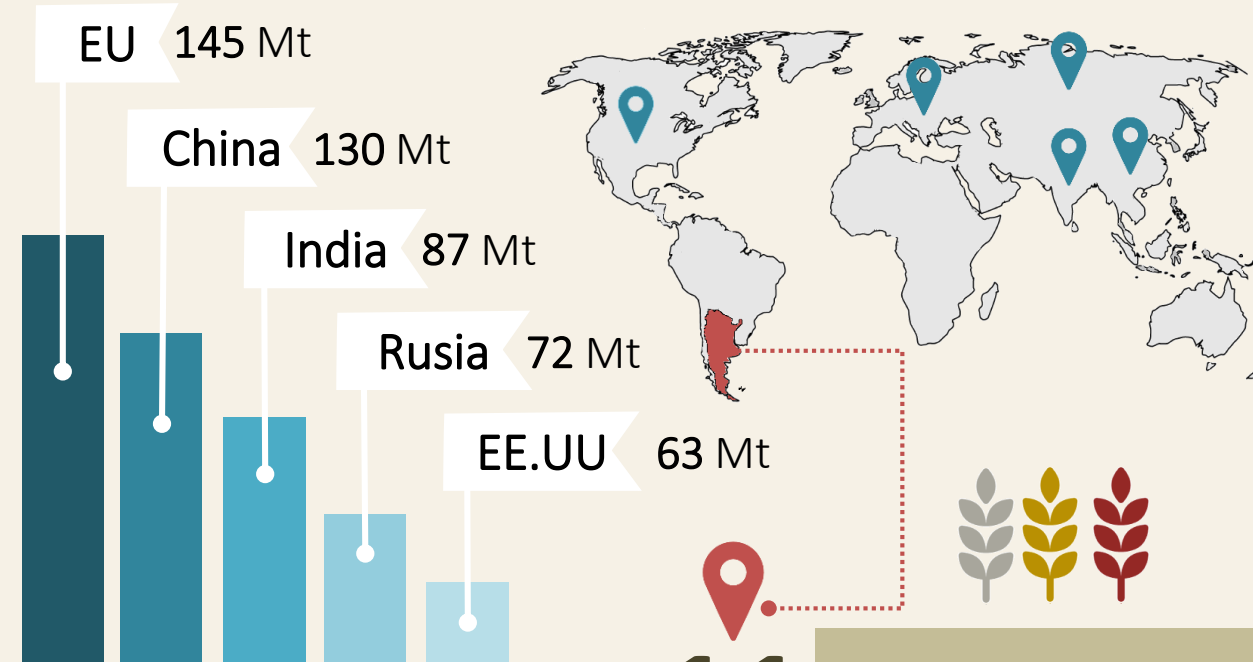
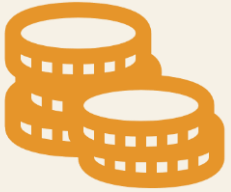
Global wheat production



760 Mt

Statistics

Exports for a total value of
83 billions US\$



Main
producers

11

18.3 Mt




Argentinean statistics

Main Winter Cereal

Record production 2017/18

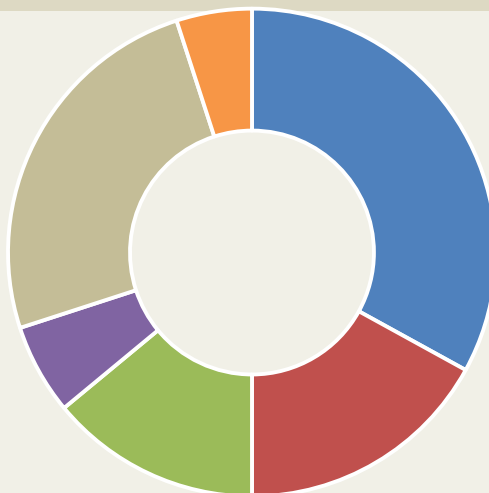
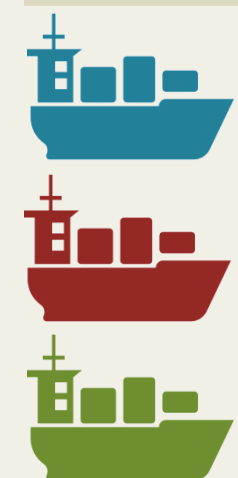
 **18.3** Mt

 **6.3** Mha

 **2,904** kg/ha



Main destinations of the ARG wheat



- Brazil 33 %
- Indonesia 17 %
- Thailand 14 %
- Vietnam 6 %
- Others 25 %
- Egypt 5 %

(Fuente: SIIA, 2017)



Domestic consumption

6 Mt

4.5 Mt

500 Kt

73%

Breads



10%
Packages
(1 kg)

8% Dry pasta

2% Fresh pasta

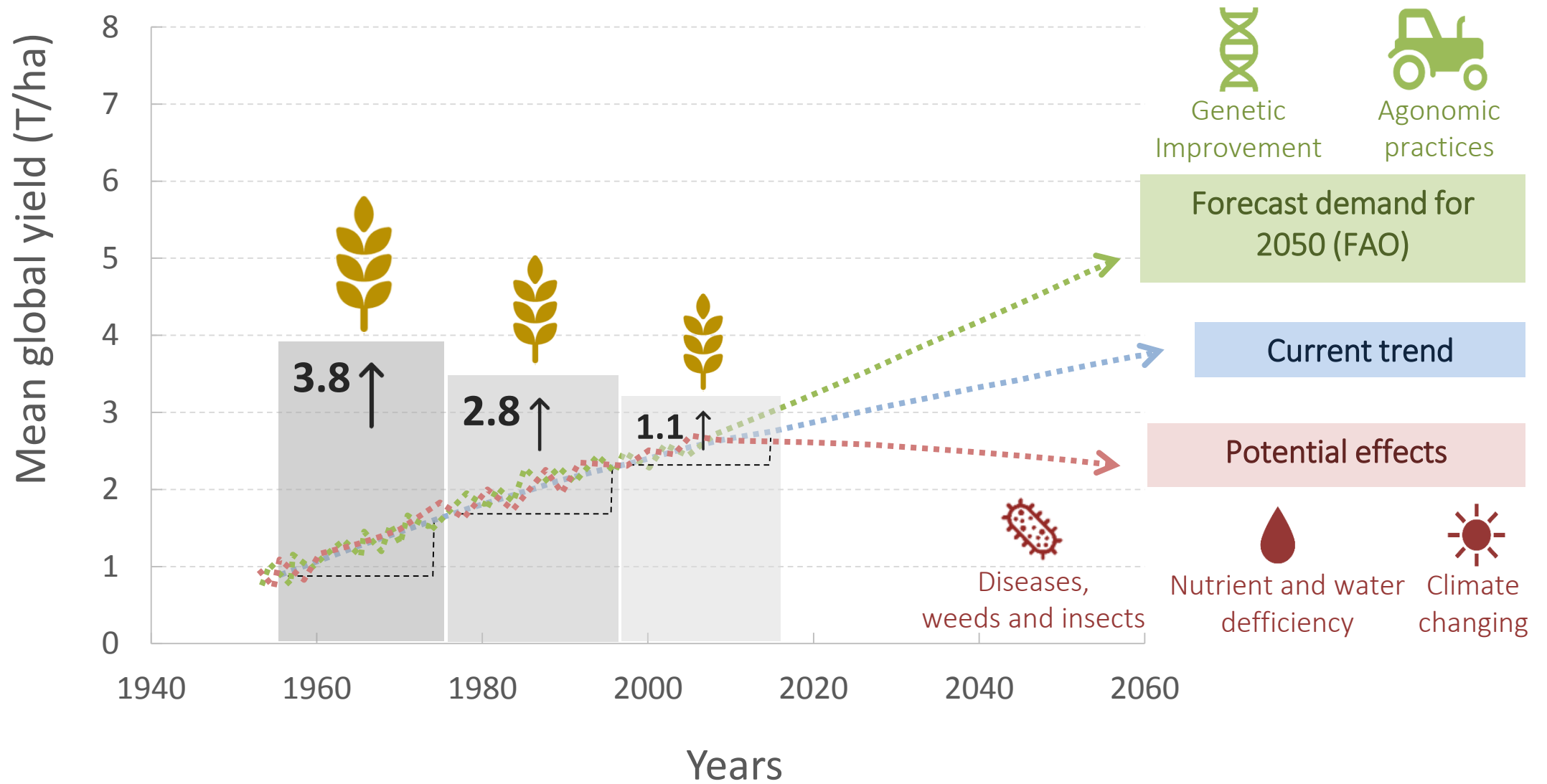


7%

Cookies
and
crackers

(Source: Federación Argentina de la Industria Molinera, 2017)



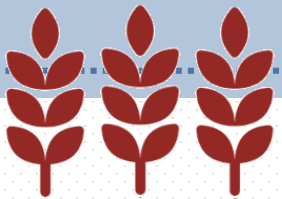




Yield

$$\text{Grain yield} = N G m^2 \times T K W$$

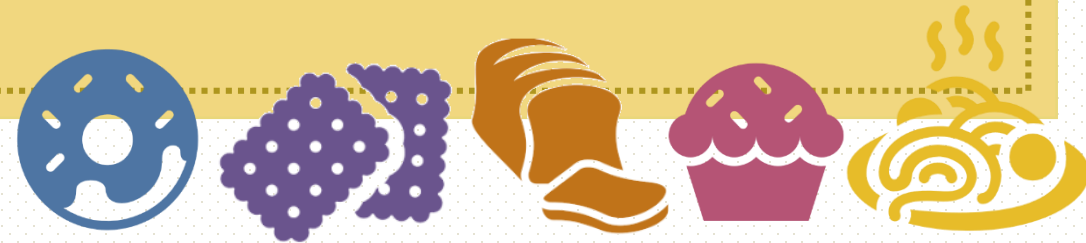
$$\text{Grain yield} = \text{Biomass} \times H I$$



Quality

Variable and dynamic concept

Criterion specify in relation to the industry



Foliar diseases of wheat

Limit grain yield and reduce quality in wheat producing areas all over the world

Tan spot

Lives at the expense of **death tissue**

Secrete **toxins** that kills the host cells



NECROTROPHIC

Pyrenophora tritici-repentis
(ana. *Drechslera tritici-repentis*)

Leaf rust

Nourishes from **living tissue**



BIOTROPHIC

Puccinia triticina

Septoria leaf blotch

Intermediate



HEMIBIOTROPHIC

(*Zymoseptoria tritici*
= *Mycosphaerella graminicola*)

Nutritional habit of the pathogen

Variable references

AUDPC (Area under disease progress curve)

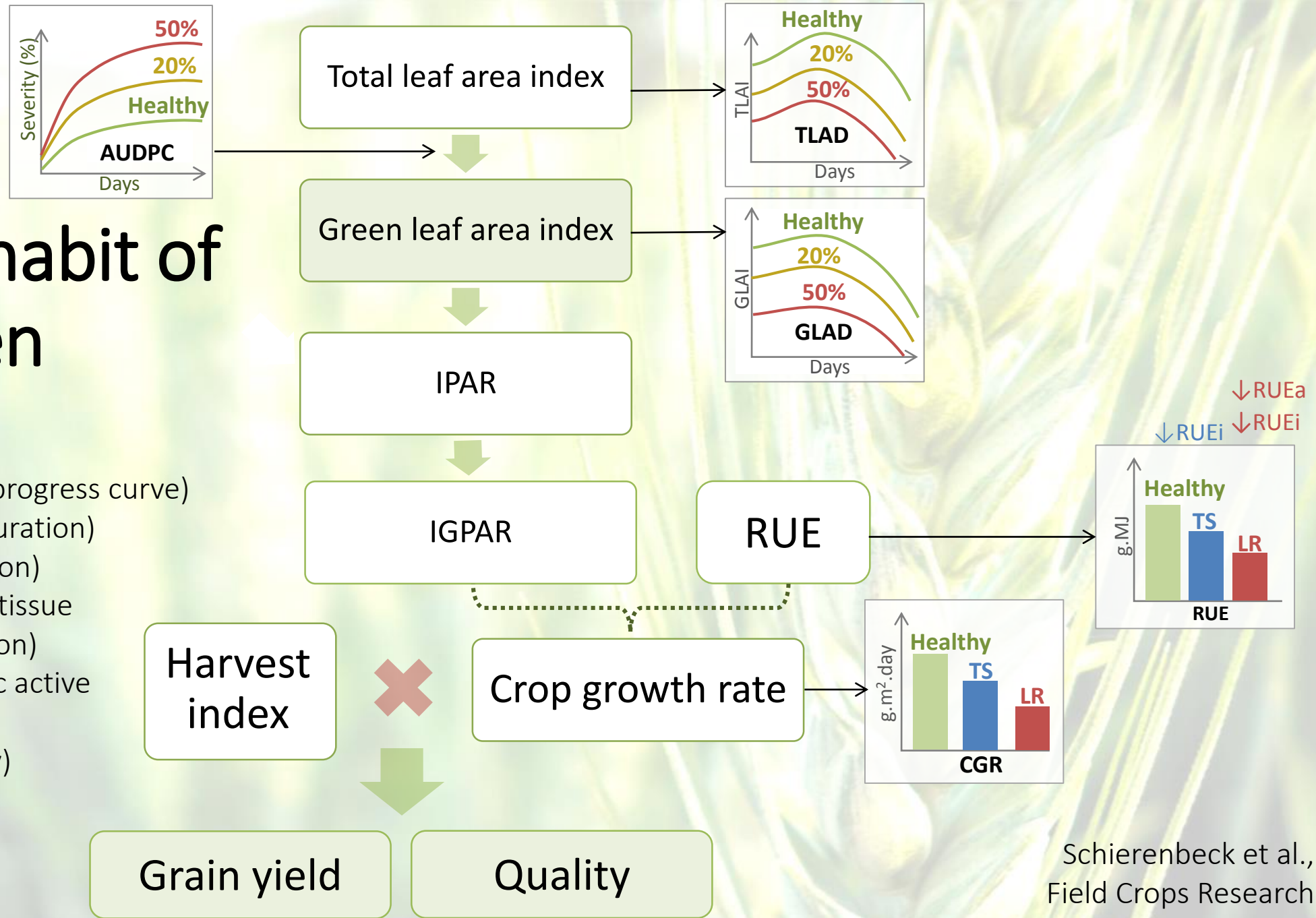
TLAD (Total leaf area index duration)

GLAD (Green leaf area duration)

IGPAR (Intercepted by green tissue photosynthetic active radiation)

IPAR (Incident photosynthetic active radiation)

RUE (Radiation use efficiency)



Schierenbeck et al.,
Field Crops Research
(2016)

Foliar diseases and their control by fungicides



Dimmock & Gooding, J Agr Sci (2002)

The influence of foliar diseases, and their control by fungicides, on the protein concentration in wheat grain: a review



Grain
protein
content?

Foliar diseases effect on grain protein content

Tan spot



NECROTROPH

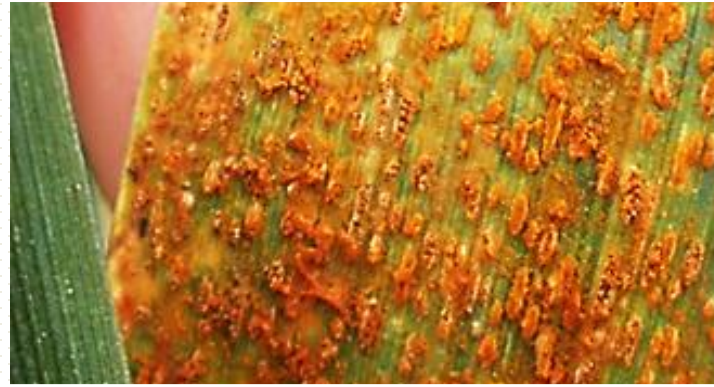
Pyrenophora tritici-repentis

Causes more damage on starch accumulation (↑GPC)



(Rees et al. 1987)

Leaf rust



BIOTROPH

Puccinia triticina

Causes more damage on N remobilization and accumulation
(↑ = ↓ GPC)



(Ash & Brown 1990,
Simón et al. 2012,
Schierenbeck et al. 2014)

Septoria leaf blotch



HEMIBIOTROPH

Zymoseptoria tritici

(↑ = ↓ GPC)



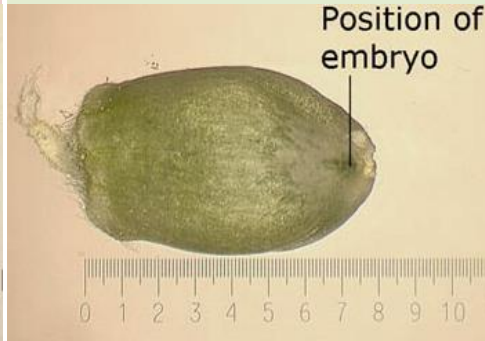
(Ruske et al. 2001,
Ishikawa et al. 2001,
Blandino and Reyneri 2009,
Liaudat 2011,
Castro 2016)

GRAIN FILLING

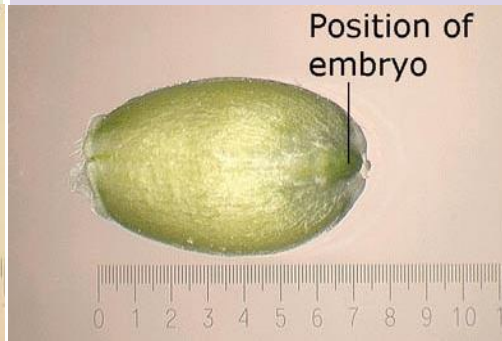
1 to 10 days



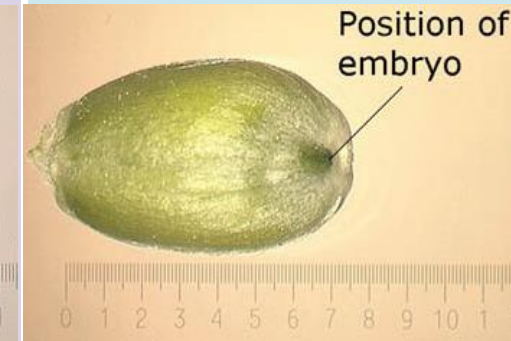
11 to 16 days



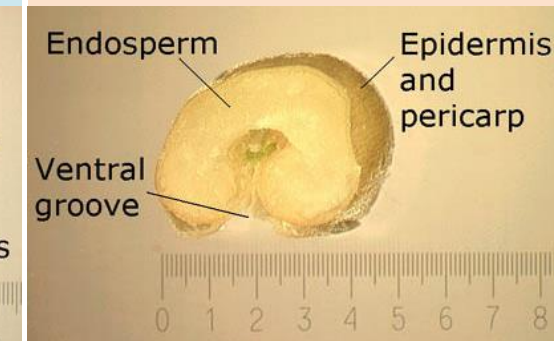
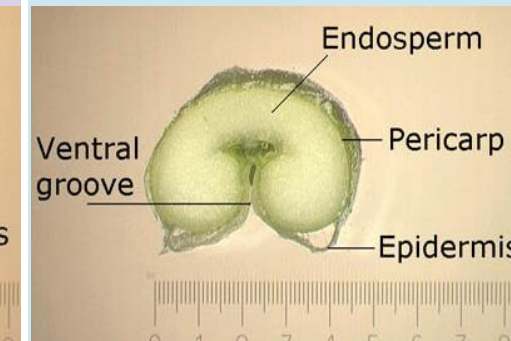
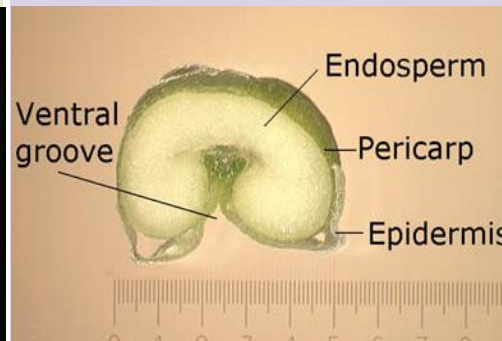
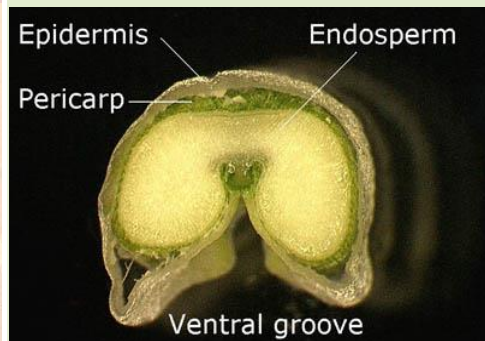
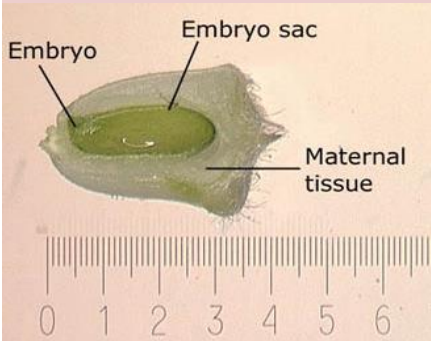
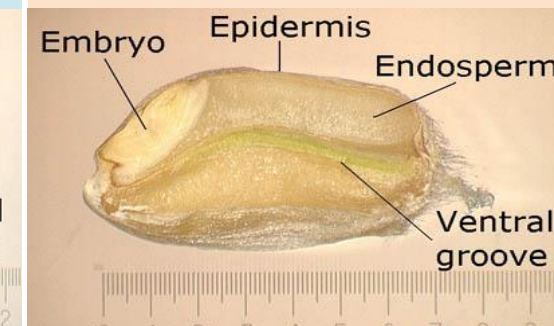
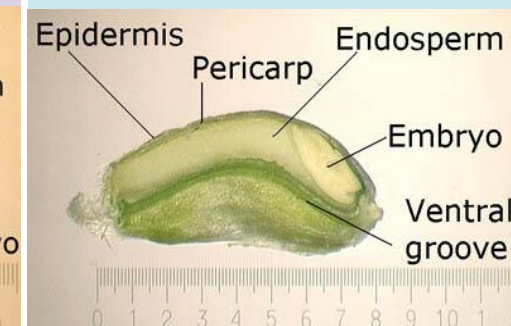
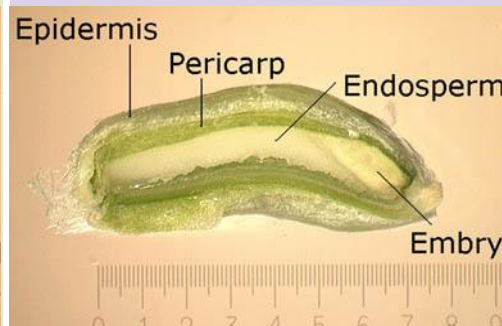
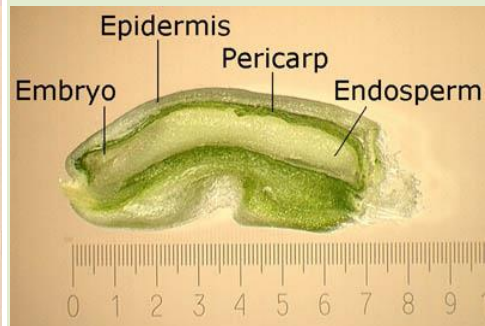
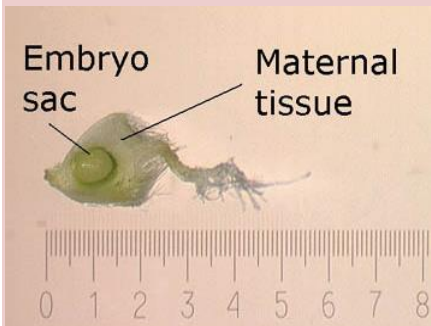
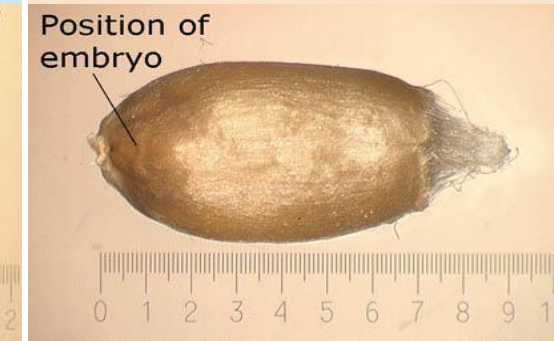
17 to 21 days



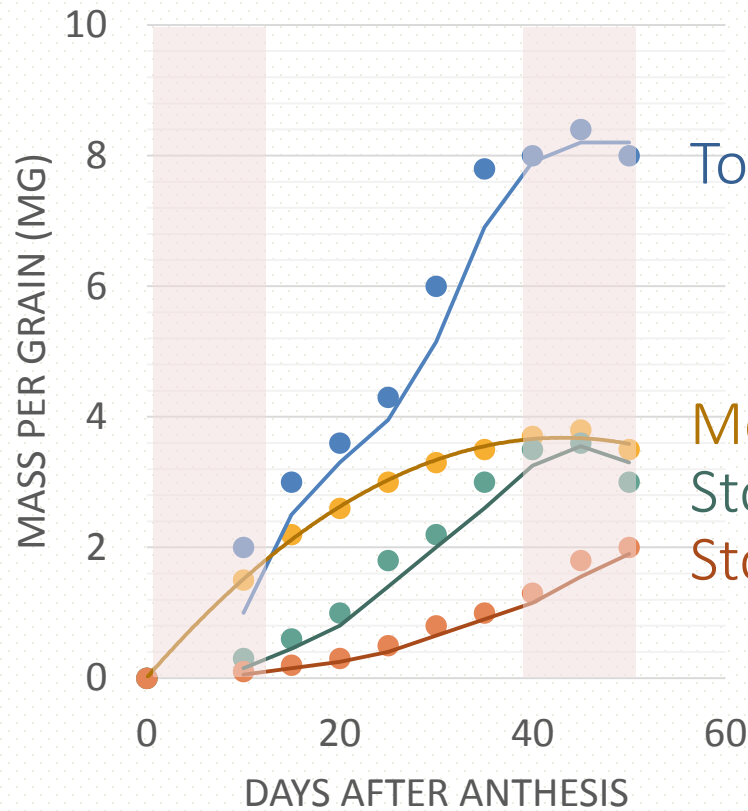
22 to 30 days



30 to 40 days



The accumulation of protein fractions in the developing grain of wheat in cv. Egret



Metabolic proteins

Storage proteins: GLIADINS

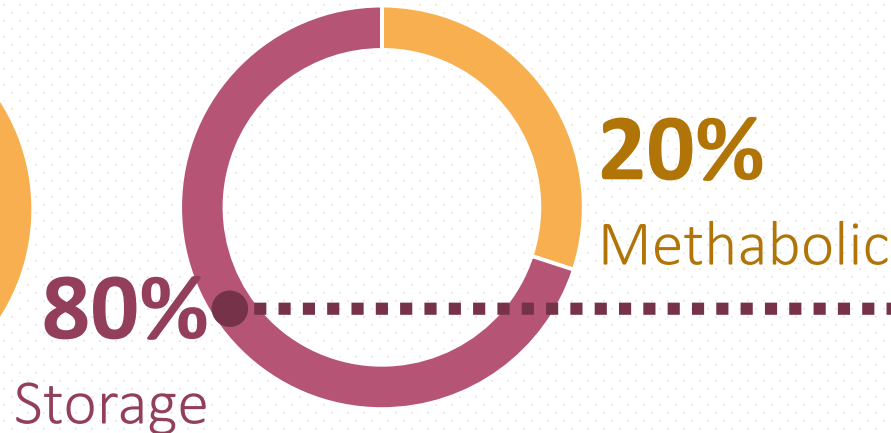
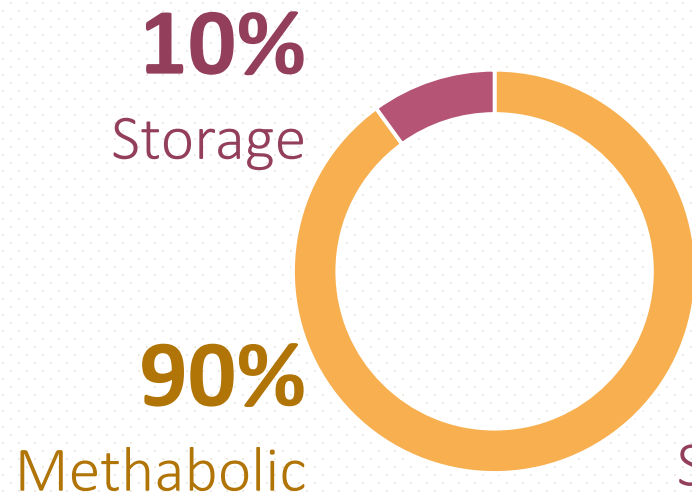
Storage proteins: GLUTENINS

30-40%

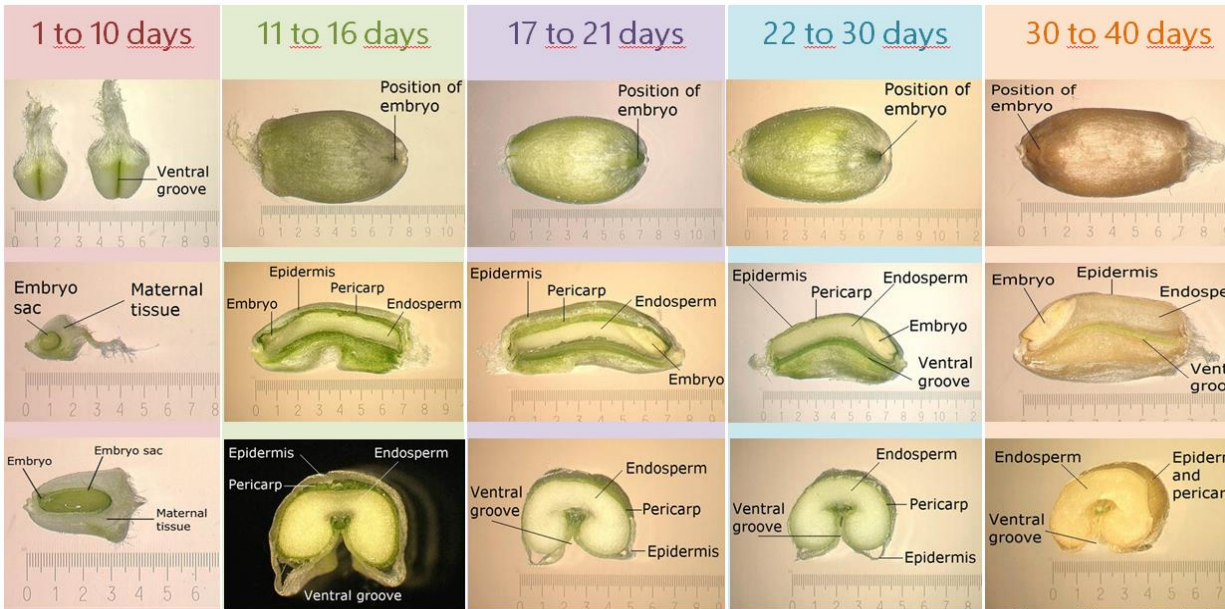
30-40%



Highly
asynchronous!



Stress during grain filling...



Grain
filling
period



Anthesis

Maturity

Stress caused by abiotic conditions



Heat stress



Drought stress

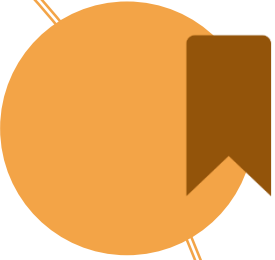


Under heat stress, the starch and protein accumulation rate increases during grain filling



The deposition of glutenins are more affected than gliadins, decreasing the glutenins/gliadins ratio (Blumenthal et al. 1993)

Objectives



To evaluate the effects of foliar diseases caused by pathogens of different habit nutrition **separately inoculated**



To evaluate **disease effect** throughout **ecophysiological traits** (GLAD) in addition to the AUDPC



To evaluate the effect of foliar diseases and fungicide applications on **breadmaking quality** of wheat



To determine **cultivars exhibiting tolerance** to the modification of dough properties caused by foliar diseases

Material and methods

EE Julio Hirschhorn (La Plata, Buenos Aires, Argentina)

2009-2015

Metehorological
conditions



Harvest in december

Sowing in June-July
Cycle I-L



250 pl/m²



50 kg P/ha at sowing



70 kgN/ha
35 at sowing
35 EC24

140 kgN/ha
35 at sowing
35 EC24



Conventional tillage

12
Field essays

Sub-plots



Healthy and
diseased treatments



Diseased
(Untreated control
≠ Inoculum
concentration)



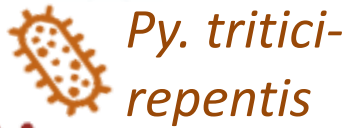
TS
Healthy



TSC
(Treated)



Z. tritici



Py. tritici-repentis



P. triticina



26

Cultivars

Quality group 1

Quality group 2

Quality group 3

Material and methods



Inoculum multiplication of the three pathogens



Spore concentration



3×10^3 spores/ml (*Py. tritici-repentis*, Ali & Franc 2003)



0,5 mg sporas/pl (*P. triticina*, Shatya 2015)



5×10^6 spores/ml (*Z. tritici*, Gerard et al. 2017)



Assessments at EC39, EC60, EC82

Severity (%) → **AUDPC**

TLAI (m² hoja/m² suelo) → GLAI → **GLAD**

Grain yield and yield components (SP, GN, TKW)



(TE) Double mixture fungicide

1 L/ha  **140** l/ha

Triazol (epoxiconazole, 50 g/ha)

Strobilurin (pyraclostrobin 133 g/ha)



(TEC) Triple mixture fungicide

1,2 L/ha  **140** l/ha

Triazol (epoxiconazole 50 g/ha)

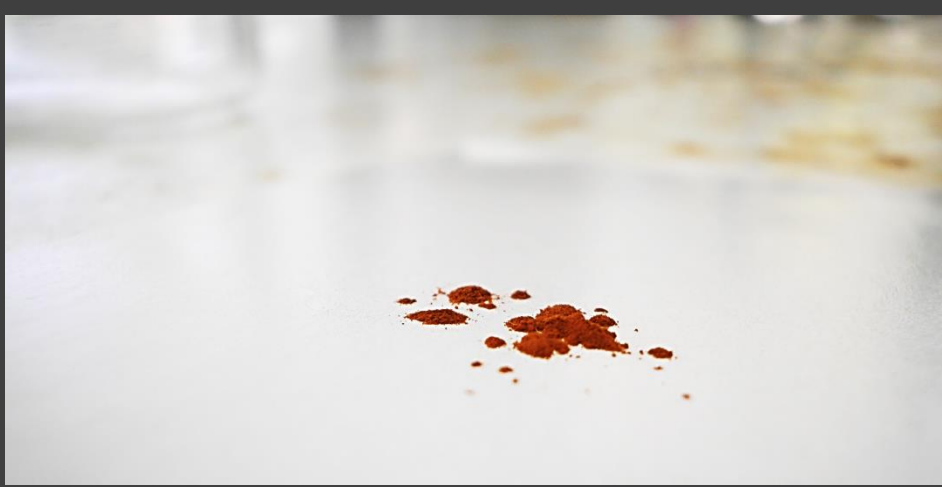
Strobilurin (pyraclostrobin 97,2 g/ha)

Carboxamide (fluxapyroxad 60g/ha)



Field essays

EE Julio Hirschhorn
Los Hornos,
Buenos Aires
Argentina
(UNLP)



Inoculum multiplication

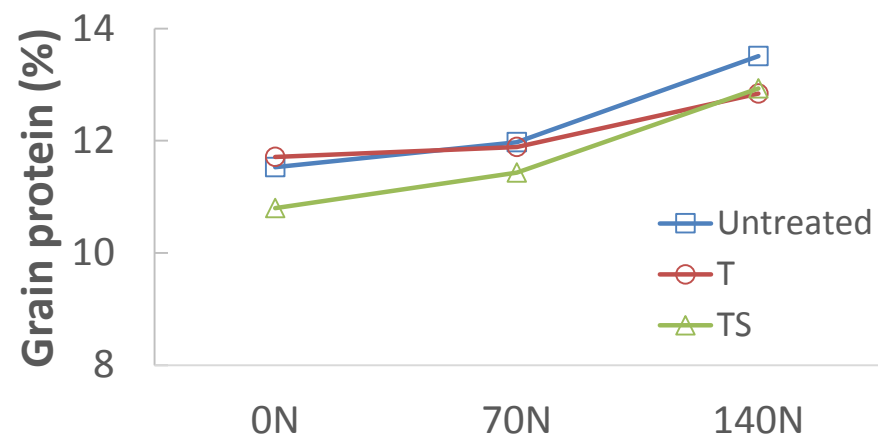
Laboratorio de Cerealicultura
Universidad Nacional de La Plata, Argentina



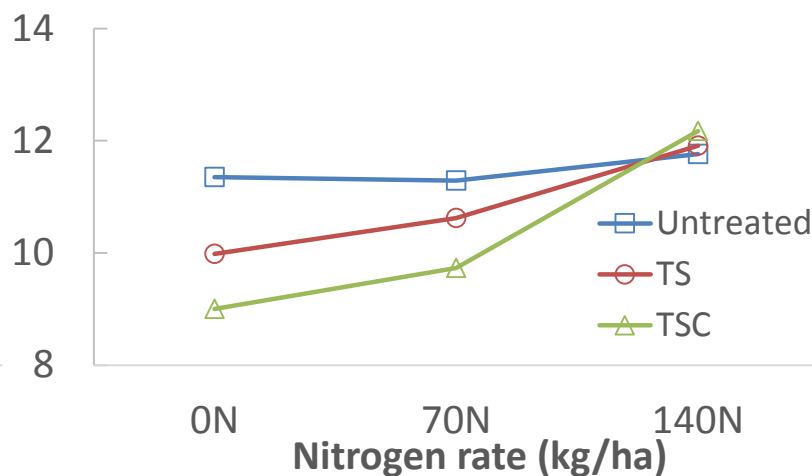
Laboratorio de Cerealicultura, Universidad
Nacional de La Plata

Molino Campodónico, La Plata, Argentina

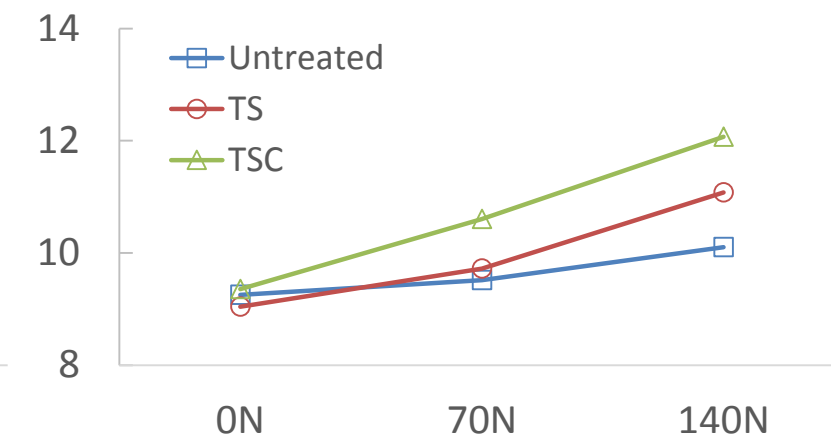
Septoria leaf blotch



Tan spot



Leaf rust

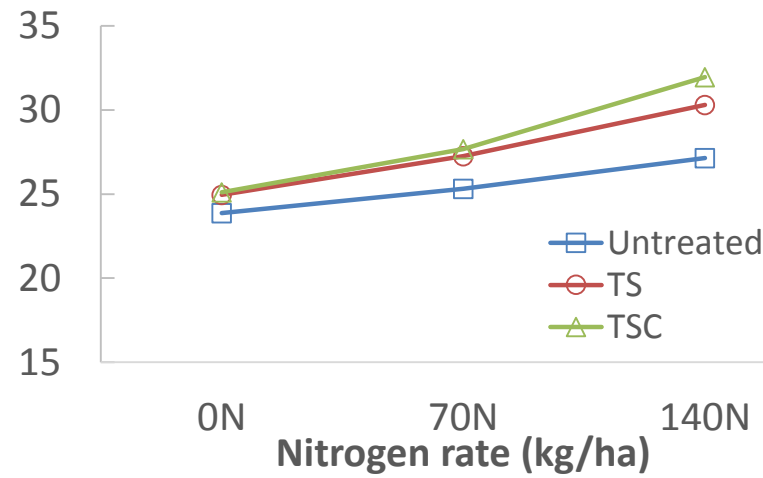


Grain protein content

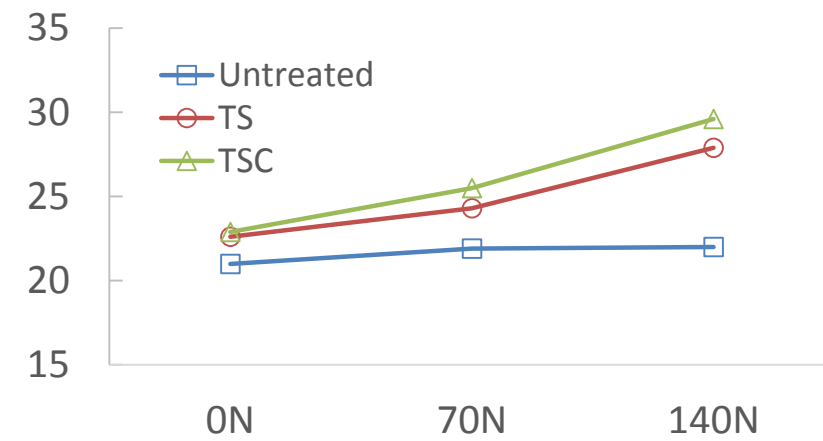
Septoria leaf blotch



Tan spot

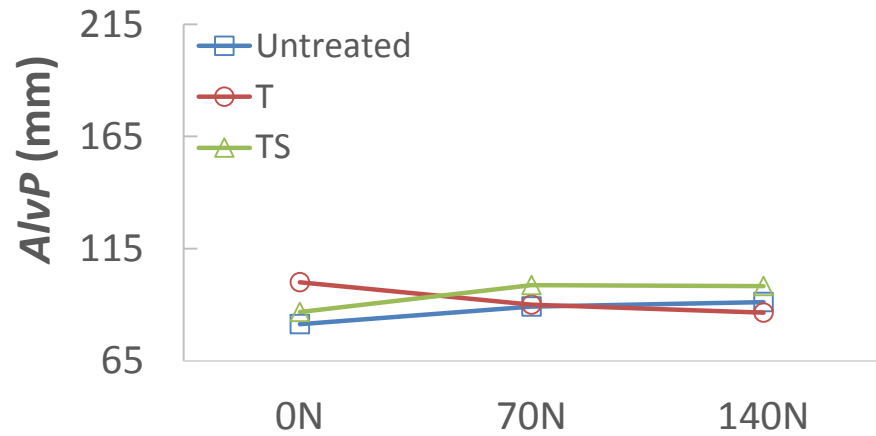


Leaf rust

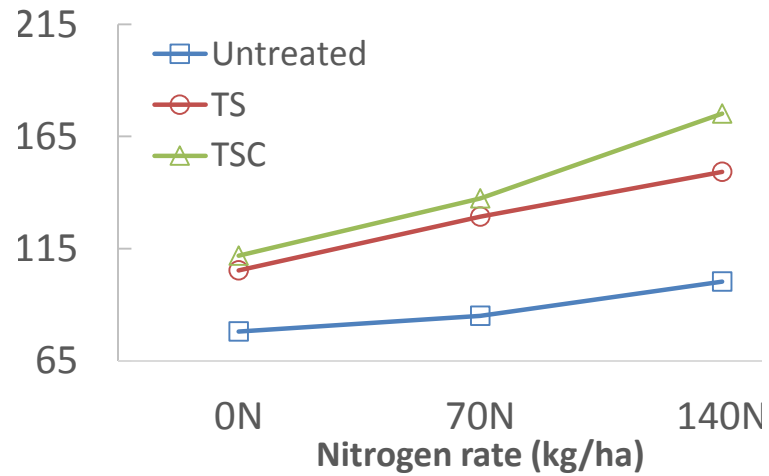


Wet gluten content

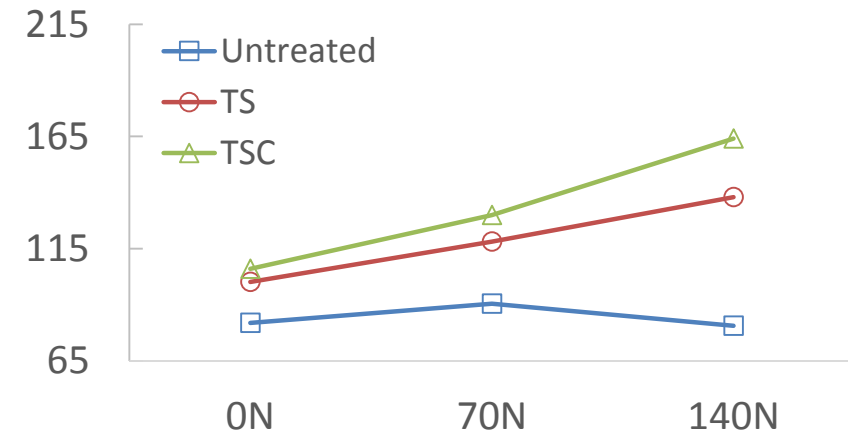
Septoria leaf blotch



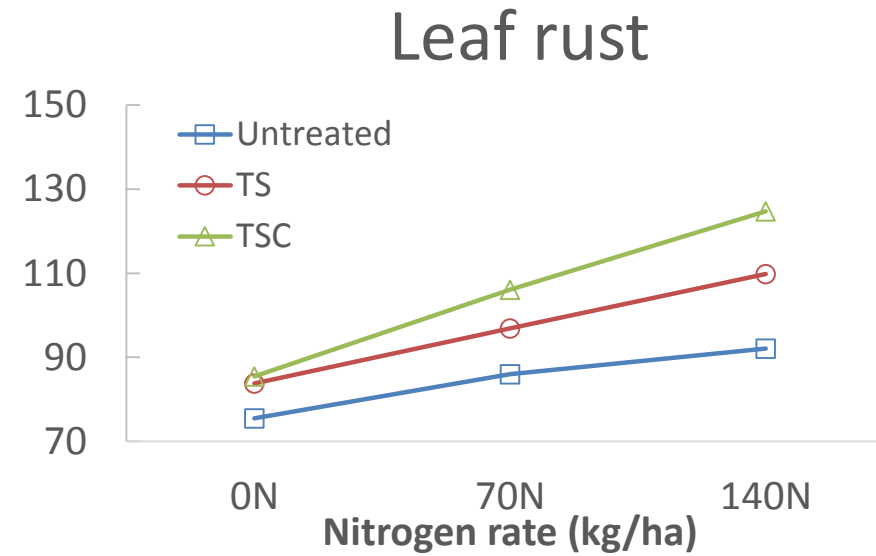
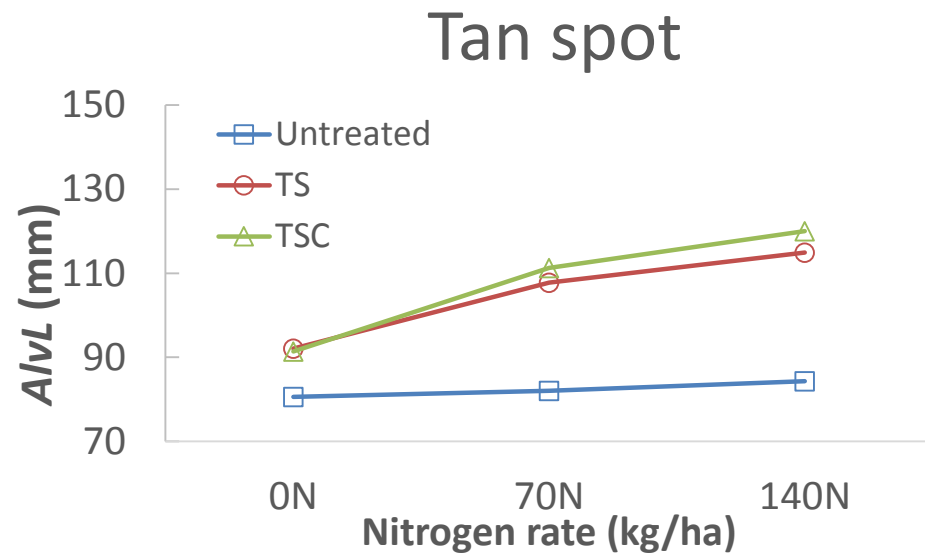
Tan spot



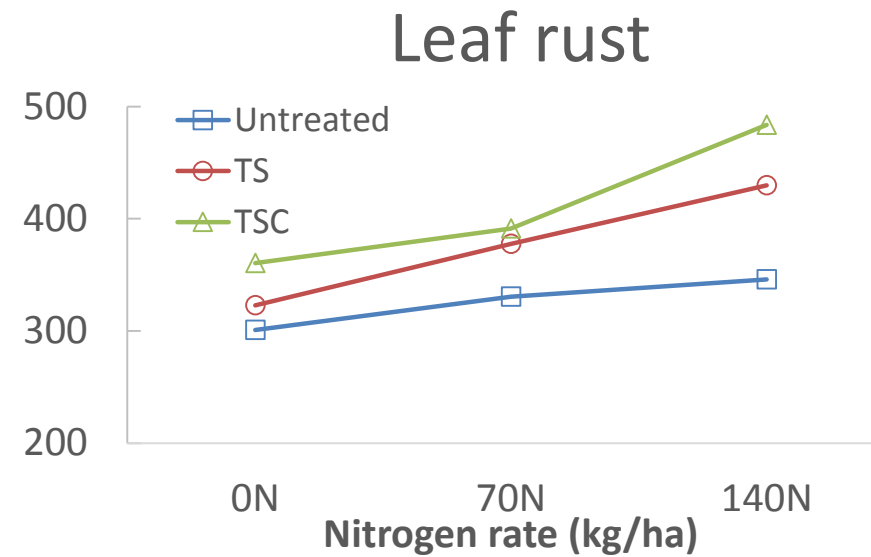
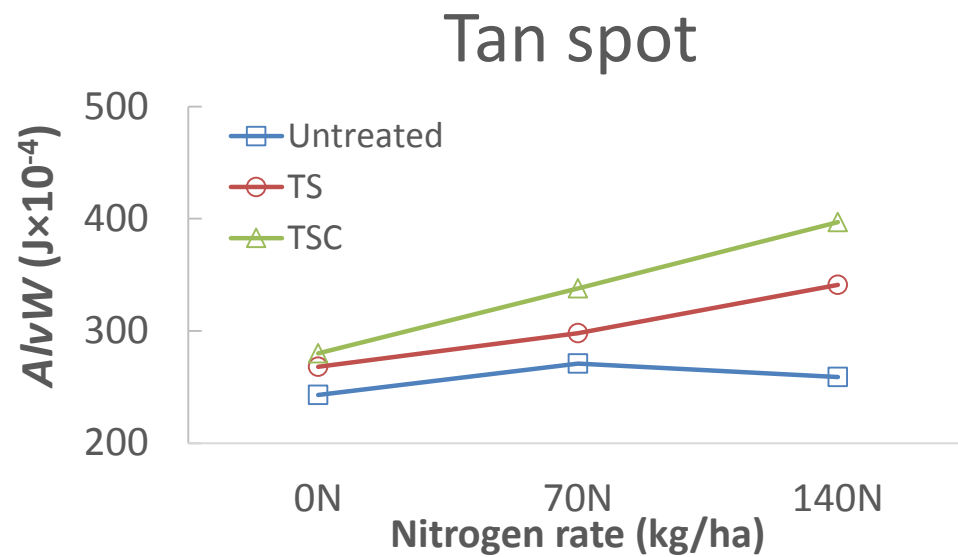
Leaf rust



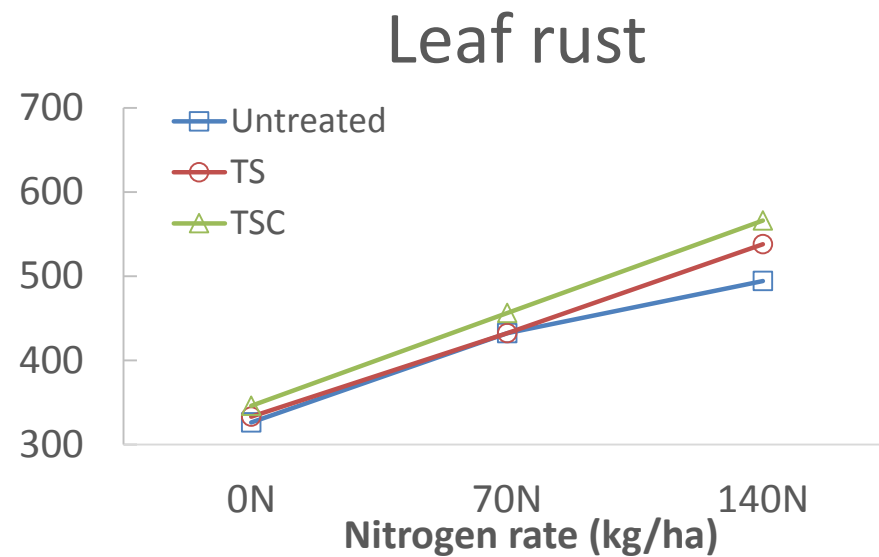
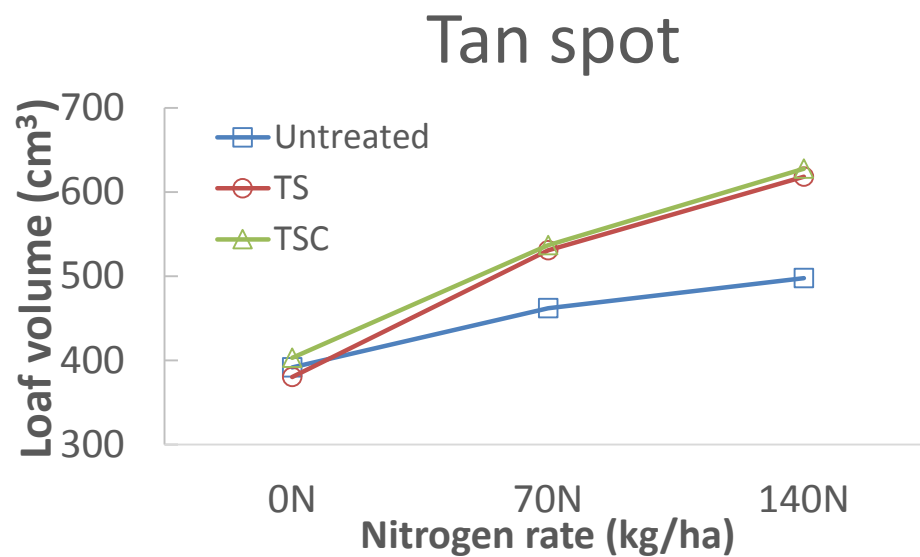
Gluten tenacity (*AlvP*)



Gluten extensibility (AlvL)

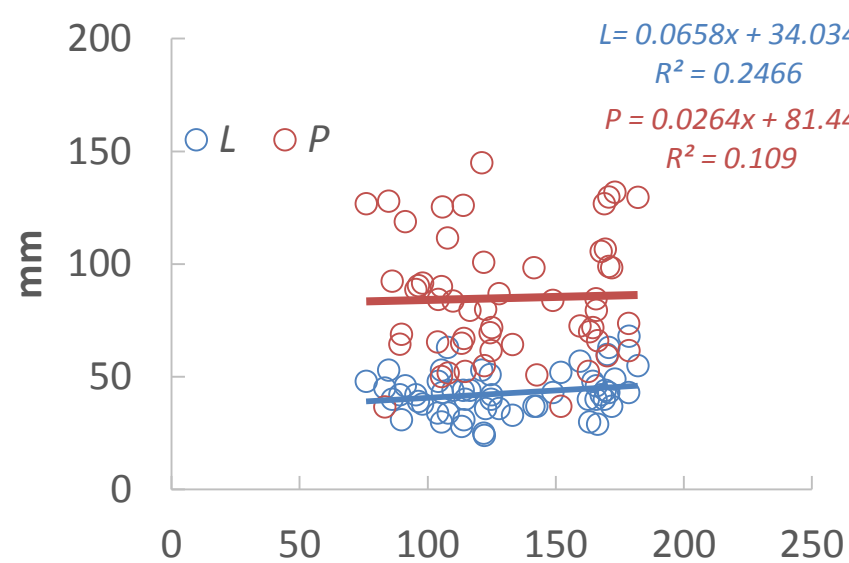


Gluten strength (AlvW)

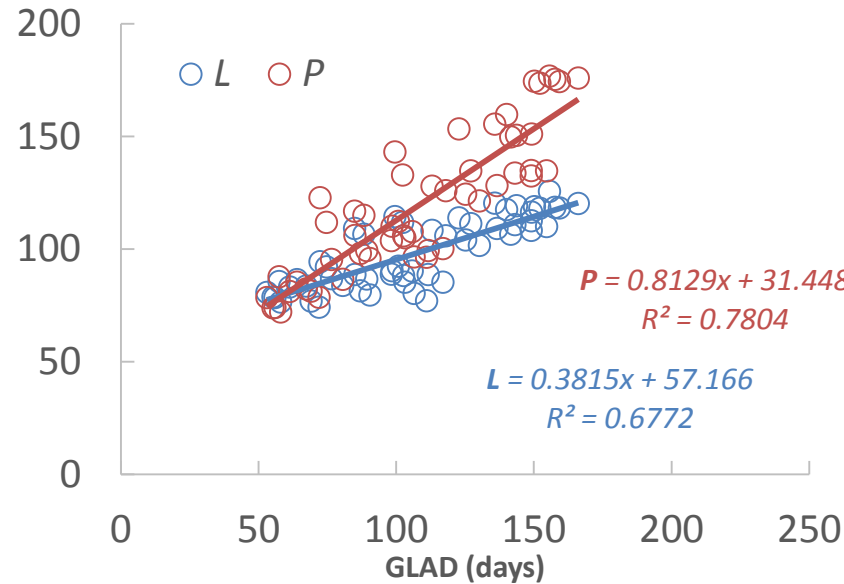


Loaf volume

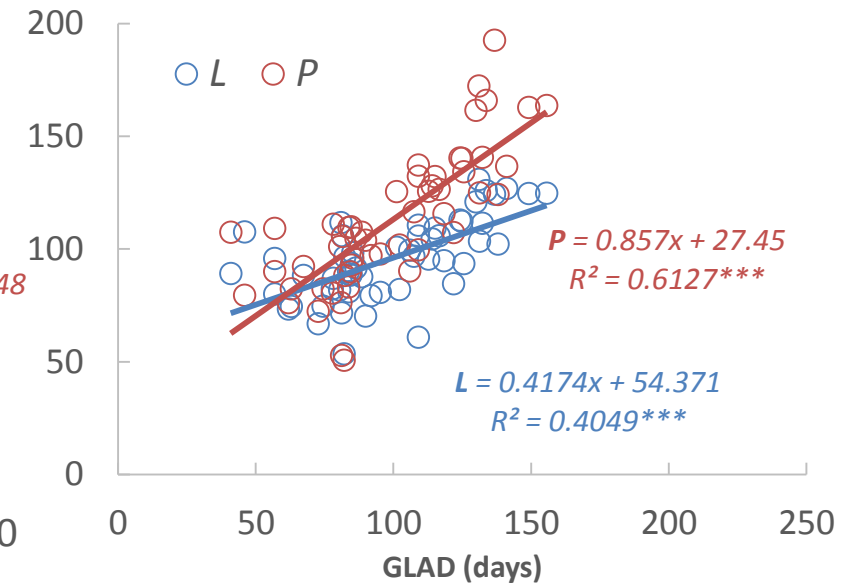
Septoria leaf blotch



Tan spot



Leaf rust



Regression lines between GLAD and AlvP or AlvL in three cultivars of wheat inoculated with *Z. tritici*, *Py. tritici-repentis* and *P. tritricina*

Summary

Foliar diseases affected not only **quantity** but also **quality of gluten**.

Under severe **tan spot** and **Septoria leaf blotch** infections, since the pathogens tended to **increase GPC**, fungicide applications caused decreases that could be prevented with **nitrogen fertilization**. Higher GPC, was not always associated with breadmaking improvement.

Under severe **leaf rust** infections GPC ↓, on a balance, **N remobilization was more affected** than starch accumulation

Leaf rust and **tan spot**, also **affected the $AlvP/L$ ratio** ascribed to shorter grain filling periods (↓GLAD) where glutenins accumulation is more sensitive than gliadins

Some **cultivars exhibited tolerance** to foliar diseases regarding grain yield loss and **dough rheology modifications**, particularly those belonging to QG1



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journal homepage: www.elsevier.com/locate/fcr



Does radiation interception or radiation use efficiency limit the growth of wheat inoculated with tan spot or leaf rust?

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^b CONICET CCT La Plata, Calle 8 N° 1467, La Plata, Buenos Aires, Argentina

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Breadmaking quality and yield response to the green leaf area duration caused by fluxapyroxad under three nitrogen rates in wheat affected with tan spot

María Constanza Fleitas^{a,b,*}, Matías Schierenbeck^{a,b}, Guillermo Sebastián Gerard^{a,b}, Juan Ignacio Dietz^{a,b}, Silvina Inés Golik^a, María Rosa Simón^{a,c}

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^b CONICET CCT La Plata, La Plata (1900), Buenos Aires, Argentina

^c CIC, La Plata (1900), Buenos Aires, Argentina



Quality and yield response to the control of *Mycosphaerella graminicola* in wheat as affected by nitrogen rate and cultivar bread-making characteristics

María Constanza Fleitas^{A,B,D}, Ana Carolina Castro^{A,B}, and María Rosa Simón^{A,C}

^A Cerealicultura, Facultad de Ciencias Agrarias y Forestales, Universidad Nacional de La Plata, La Plata (1900), Buenos Aires, Argentina.

^B CONICET CCT La Plata, La Plata (1900), Buenos Aires, Argentina.

^C CIC, La Plata (1900), Buenos Aires, Argentina.

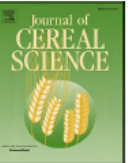
^D Corresponding author. Email: constanzafleitas@gmail.com



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How leaf rust disease and its control with fungicides affect dough properties, gluten quality and loaf volume under different N rates in wheat

María Constanza Fleitas^{a,b,*}, Matías Schierenbeck^{a,b}, Guillermo Sebastián Gerard^{a,b}, Juan Ignacio Dietz^{a,b}, Silvina Inés Golik^a, Pablo Eduardo Campos^c, María Rosa Simón^{a,d}

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Norman E. Borlaug

There are 6.6 billion people on the planet today. With organic farming we could only feed 4 billion of them. Which 2 billion will volunteer to die?



Gracias!

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