Virulence and epidemiology of *Puccinia graminis* f.sp. *tritici* in Ecuador in 2016

Charles Barnes

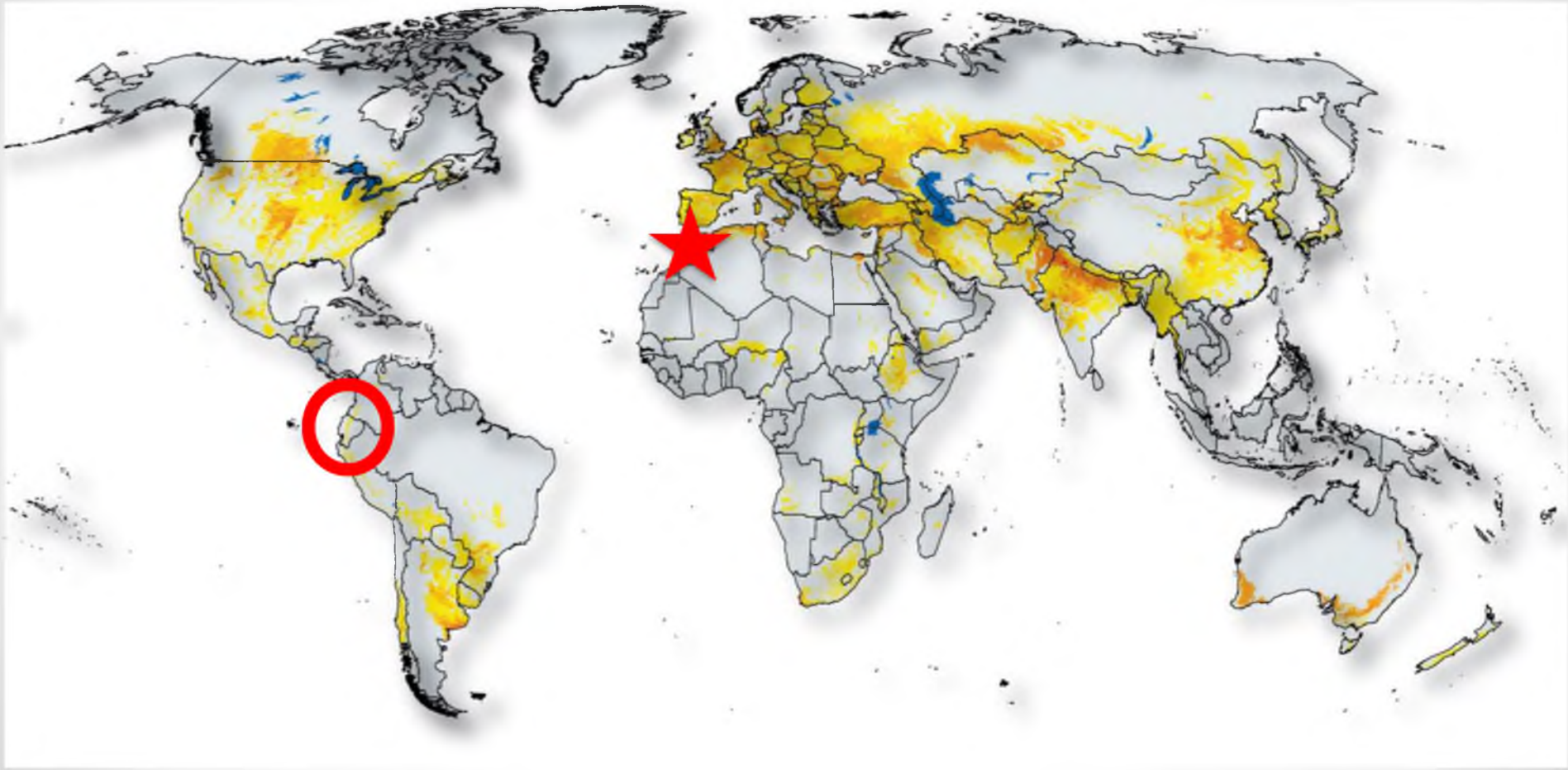
INIAP - Estación Experimental Santa Catalina

- Instituto Nacional de Investigaciones Agropecuarias
- National Agriculture Research Institute

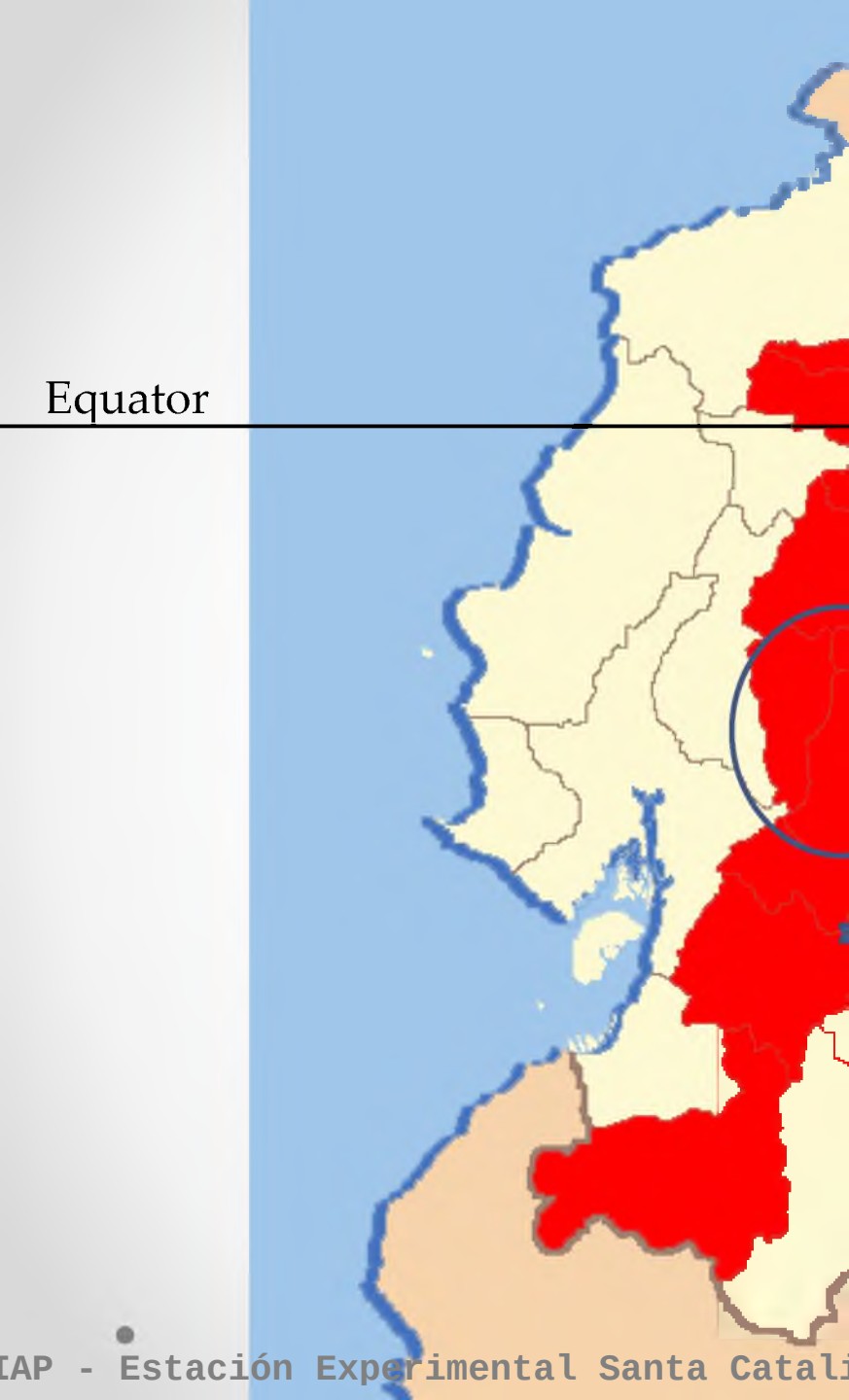
The Pgt Group

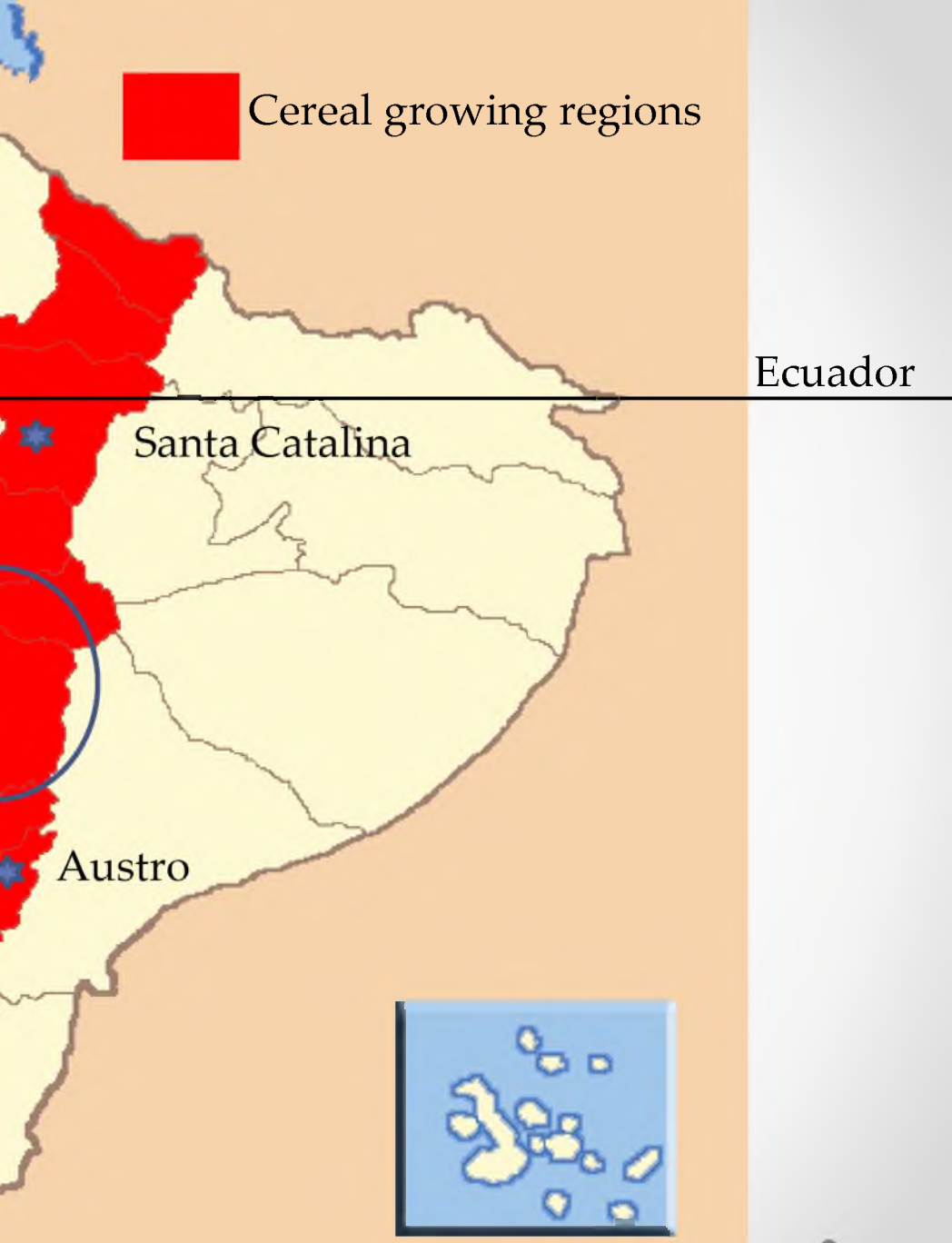
- Ecuador
  - **Charles W. Barnes-INIAP**
  - **Maria E. Ordóñez-PUCE**
- Canada-Agriculture Canada
  - **Tom Fetch**
  - **Sarah Hambleton**
  - **Kasia Dadej**
- United States-USDA-ARS
  - **Les Szabo**

Wheat Growing Regions



http://wheat.org/wheat-in-the-world


Equator


Cereal growing regions
Ecuador
Santa Catalina
Austro

History of INIAP

- **1961**. INIAP was founded on a public farm of the National Wheat Commission- Now Santa Catalina
- **1966**. International wheat meeting, INIAP was designated Headquarters of High Altitude Wheat Research.

En la Reunión Internacional del Trigo, Ecuador fué designado Sede de Investigaciones de Trigos de Altura. Aquí, los especialistas asistentes visitan "Santa Catalina"

Why Ecuador

A lot of rust at Santa Catalina

- Oats
  - Grown all year long for cattle
  - Dominated by stem rust, some crown rust

Why Ecuador

A lot of rust at Santa Catalina

- Sentinel plot during off season
  - Leaf rust on wheat, barley, and rye in January-February
  - Stripe rust appears on wheat and barley mid February

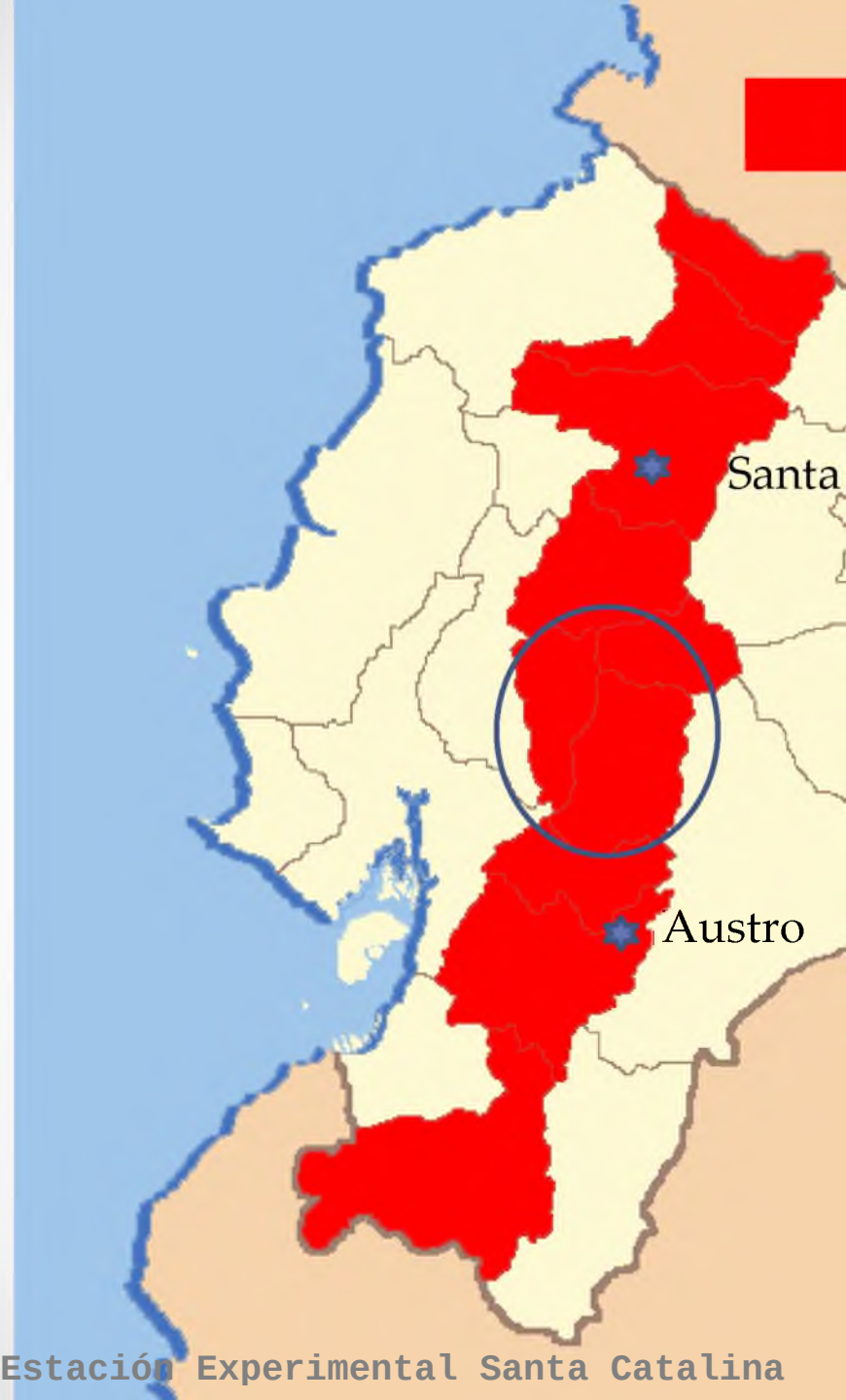
Why Ecuador

A lot of rust at Santa Catalina

- Cereals sown late Feb -harvested late July
  - Stripe rust predominates
    - 2015-2016, 96 samples of Psh, Pst, 53 races (X. Chen)
  - Stem rust on wheat and rye by the end of July
    - Races largely unknown, except for the RRTTF

The 2 stations

- Santa Catalina
  - Evaluate > 2,000 lines per year
  - Wheat-CIMMYT-Mexico
  - Barley-U of Alberta, ICARDA-Morocco, PBI-Australia
- Austro
  - Small-mix of everything
  - Just a few lines, but more area


Santa
Austro

Cereal growing regions

The wheat in Austro

- UC-Davis line containing *Sr38*. UC11075
- Originally sent to the Austro Station in 2012
- Field size of 200 m^2 — but just one line
  - vs Santa Catalina 2,000+ lines
- February 2016 Pgt RRTTF outbreak.

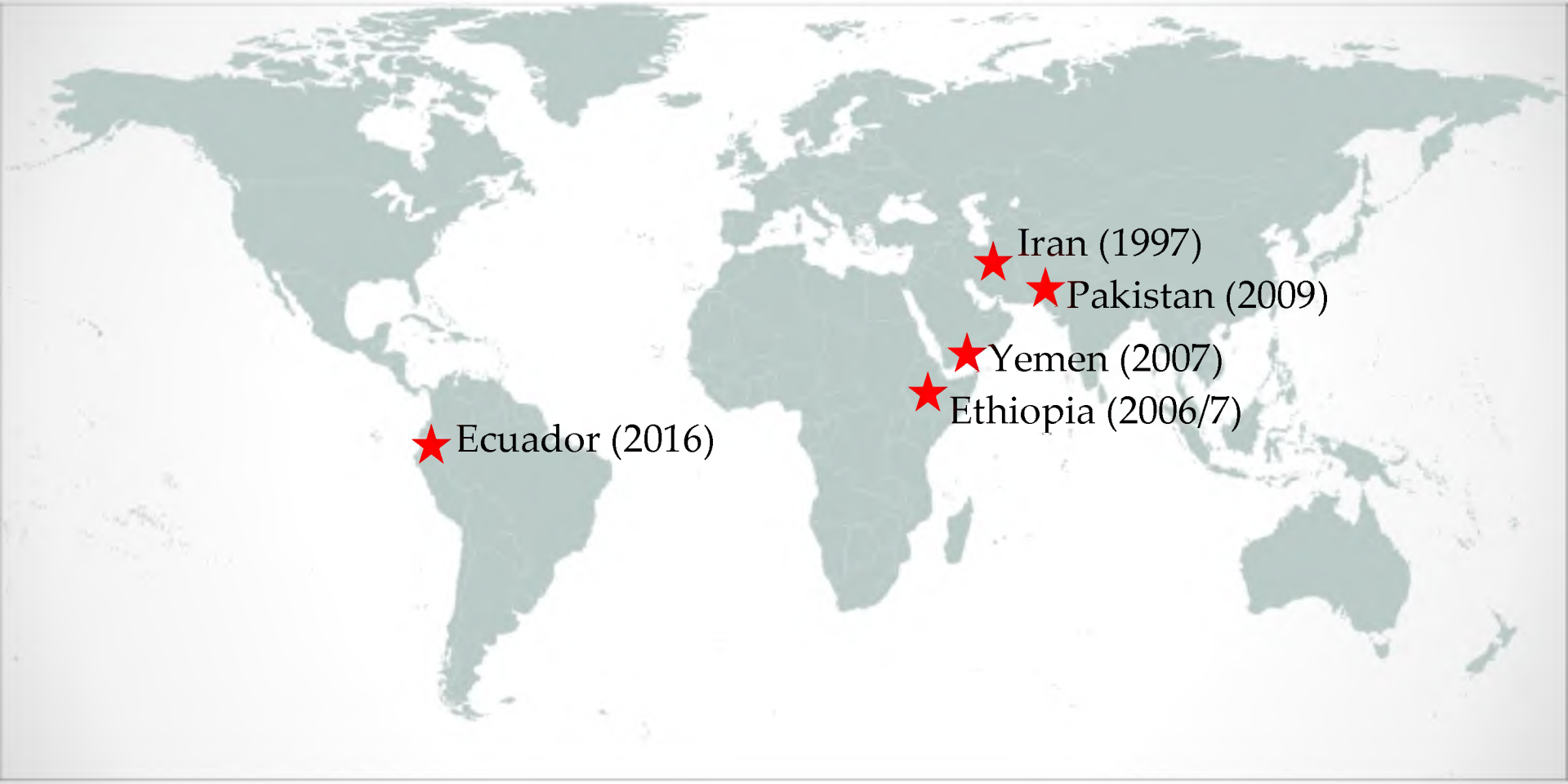
RRTTF

INIAP - Estación Experimental Santa Catalina

Identification

- Pathotyped
  - RRTTF: Agriculture-Agri Food Canada-Morden
- Genotyped
  - SSR markers: Agriculture-Agri Food Canada-Ottawa
  - SNP markers: Cereal Disease Laboratory-MN USA/ Race Group III (RRTTF/TRTTF)
    - Matched samples from Ethiopia, Pakistan and Yemen

Distribution of RRTTF



Santa Catalina

- The RRTTF infections were not as severe
- Other races
  - Virulence on *Sr13*
  - Virulence on *Sr27*

Severity

February 2016
Austro station (southern)

Prevailing winds

July 2016
Santa Catalina (northern)

Spore movement


Cereal growing regions
Santa Catalina
275 km
Austro


INIAP - Estación Experimental Santa Catalina


INIAP - Estación Experimental Santa Catalina


INIAP - Estación Experimental Santa Catalina

How prevalent is RRTTF?

- Was found in the north and south in Ecuador
- Little wheat grown in Ecuador, variable locations, variable sowing dates

Year	Production (FAOSTAT)	Year	Wheat Consumption (INIAP)
1969	94,100 tonnes	1964	9 kg/year
2016	6,746 tonnes	2015	43 kg/year

Alternative hosts

- Lots of rusts on lots of grasses

Host species	Rust species				ITS sequence			
	Puccinia holcina	*Puccinia coronata*	*Puccinia striiformis*	*Puccinia graminis*	*Puccinia* sp.	*Edythea* sp.	*Uromyces transversalis*	*Uromyces pencanus*
Agrostis sp.	-	-	-	-	3	-	-	-
Anthoxanthum sp.	-	-	2	3	2	-	-	-
Bromus sp.	-	-	-	-	2	-	-	-
B. chatharticus	-	-	1	-	-	-	-	-
Dactylis glomerata	-	-	1	-	-	-	-	-
Holcus lanatus	10	10	1	-	2	-	-	-
Nasella sp.	-	-	-	-	-	-	-	1
Sporobulus sp.	-	-	-	-	1	-	-	-
Paspalum sp.	-	-	-	-	-	1	-	-
Not identified	1	2	-	-	1	-	-	-
Berberis sp.	-	-	-	-	-	1	-	-
B. grandiflora	-	-	-	-	-	1	-	-
B. hallii	-	-	-	-	-	1		
Gladiolus sp.	-	-	-	-	-	-	1	-
Luzula sp.	-	-	-	-	-	1	-	-
Total	11	12	5	3	11	5	1	1
Lolium sp.				1	1	**Visually**		
Elymus sp.				1				

Berberis species

- **Maybe 30 or more *Berberis* species in Ecuador**
  - **Tropicos website. Records 200+ years.**
- **6 *Berberis* species from DNA sequence**
- **7 rust species from DNA sequence**
  - **6 *Edythea* species**
  - **1 Pucciniales**
  - **No *Puccinia* to date**
  - **Every *Berberis* has a rust**

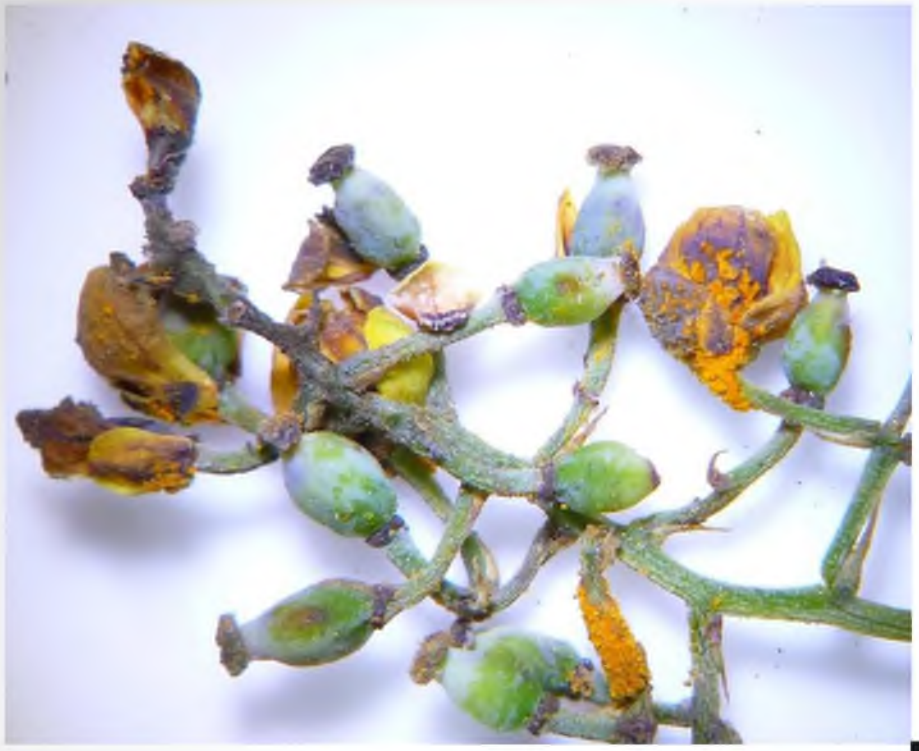
- **Hybridization? New Susceptibility?**
  - **Radhika Bartaula et al 2018**

From Tropicos
Missouri Botanical Garden


INIAP - Estación Experimental Santa Catalina

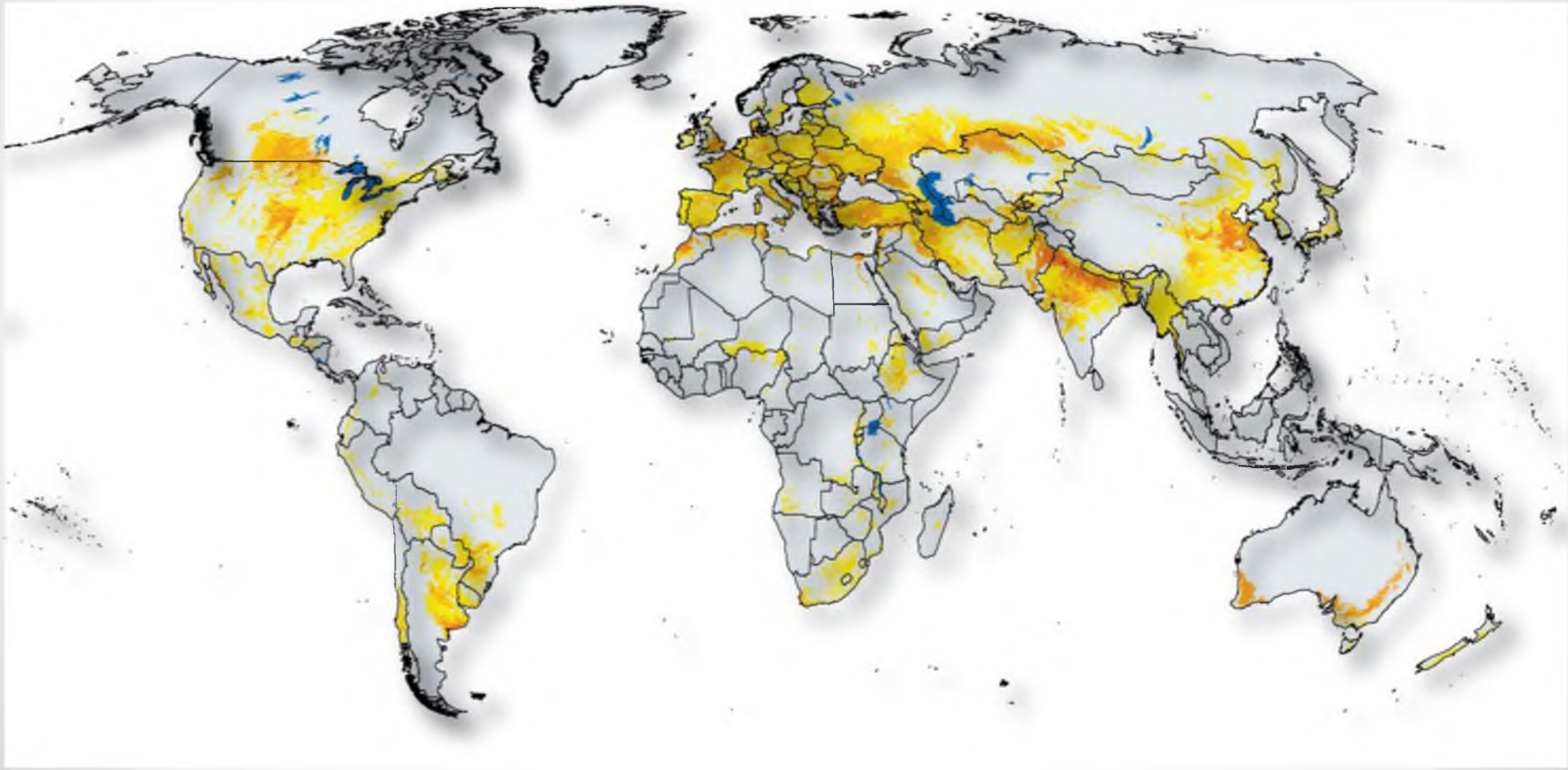

INIAP - Estación Experimental Santa Catalina


INIAP - Estación Experimental Santa Catalina



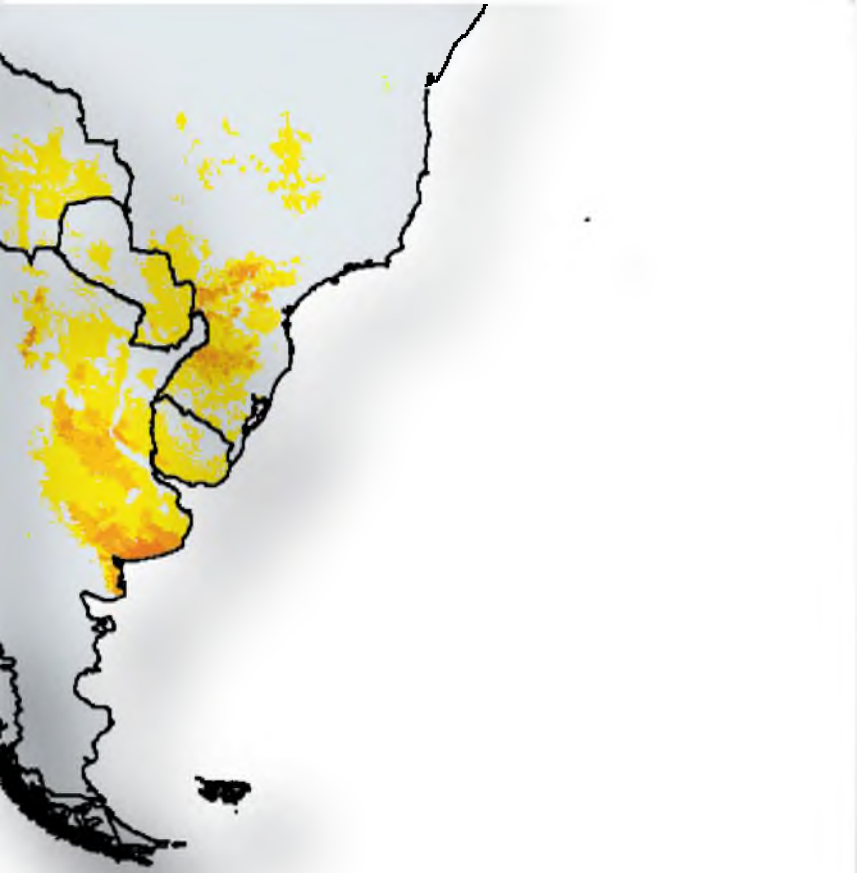
There is always rust

Conclusion



http://wheat.org/wheat-in-the-world

Global surveillance is important




thank you

Special Thank you to

- BGRI
- Delivering Genetic Gain in Wheat Project-Cornell University