Recent developments concerning the population biology and control strategies of *Phytophthora infestans* in Latin America

Acuña, Ivette[1]; Silvia Restrepo[2]; Hector Lozoya[3]; Julio Gabriel[4] y Rafael Mora[5]
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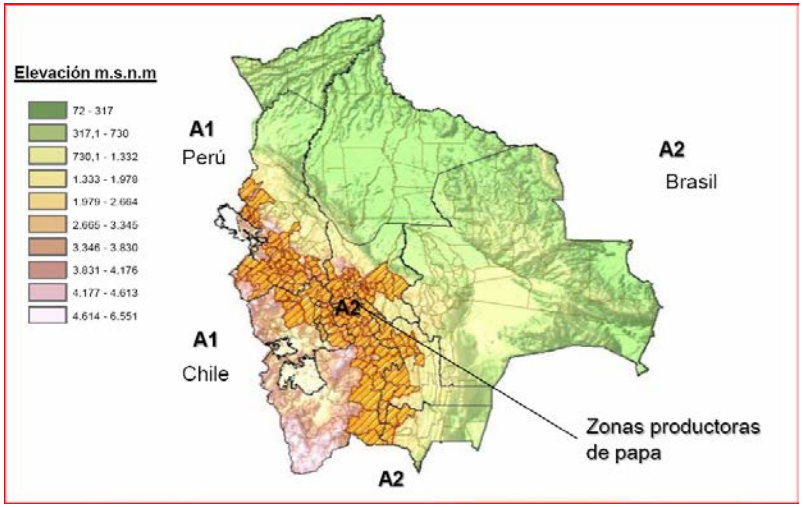
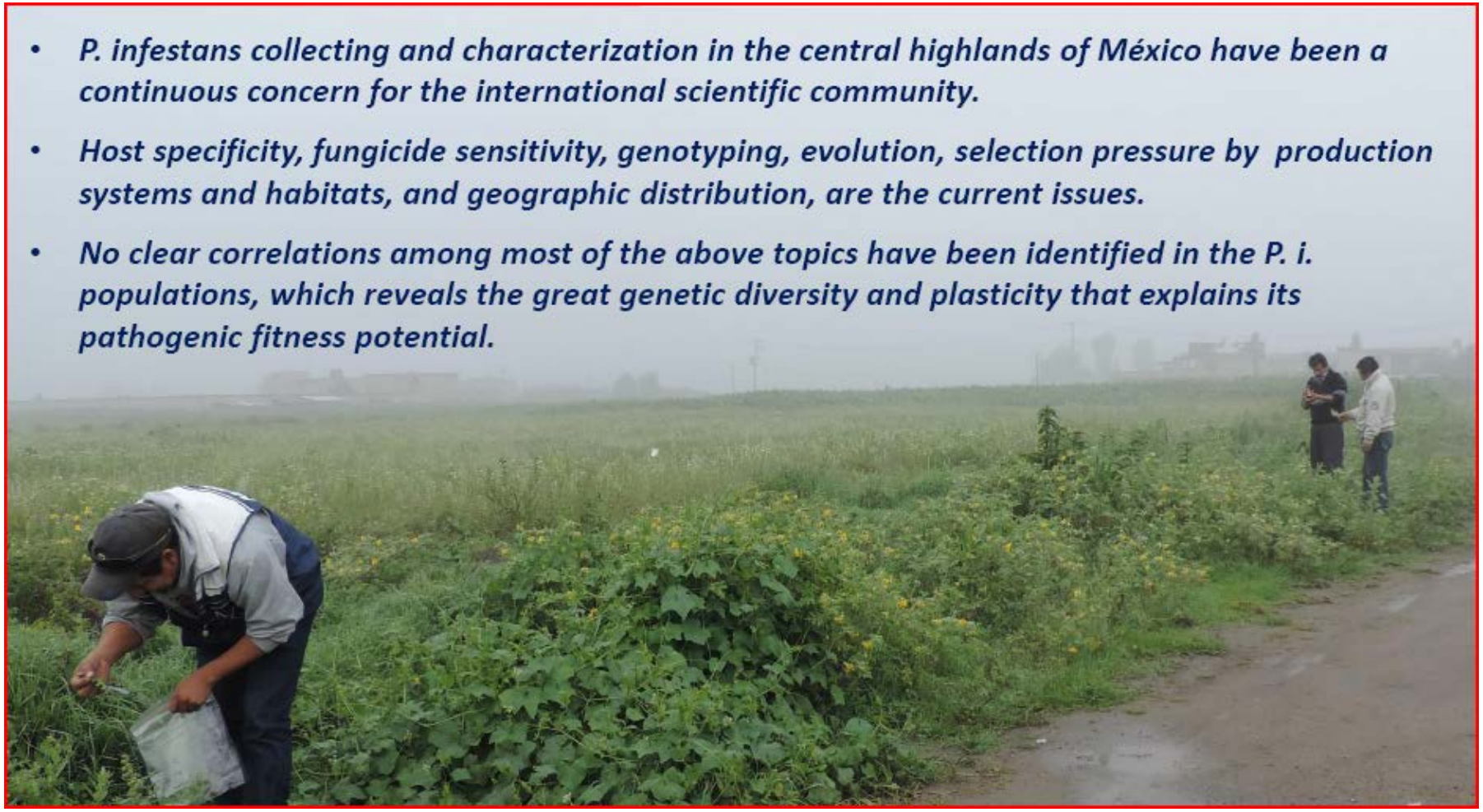
Late blight: History

- The center of origin of the disease is America, where the pathogen co-evolved with a large diversity of Solanaceous species.
- There are two theories:
  - Center of Mexico
  - South america.
- Great genetic diversity has been found (nuclear and mitochondrial genome analysis).



Recent collecting and characterization development of *Phytophthora infestans* (Mont) de Bary, en central México.



Lozoya et al, 2014.

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Situation in Latinamerica

***P. infestans*: host**

- **Potato (*Solanum tuberosum)***
- **Yellow potato (*Solanum phureja*)**
- **Tomato (*Solanum lycopersicum*)**
- **Tree tomato (*Solanum betaceum)***
- **Lulo (*Solanum quitoense*)**
- **Uchuva (*Physalis peruviana*)**

First Report of Late Blight Caused by *Phytophthora infestans* on Cape Gooseberry (*Physalis peruviana*) in Colombia. A. M. Vargas, A. Correa, D. C. Lozano, A. González, A. J. Bernal, and S. Restrepo, Laboratorio de Micología y Fitopatología, Departamento de Ciencias Biológicas, Universidad de los Andes, Bogotá, Colombia; and P. Jiménez, Laboratorio de Fitopatología, Facultad de Ciencias, Universidad Militar Nueva Granada, Bogotá, Colombia. Plant Dis. 91:0000, 2007; published online as doi:10.1094/PDIS-91-0-00000. Accepted for publication 25 January 2007.

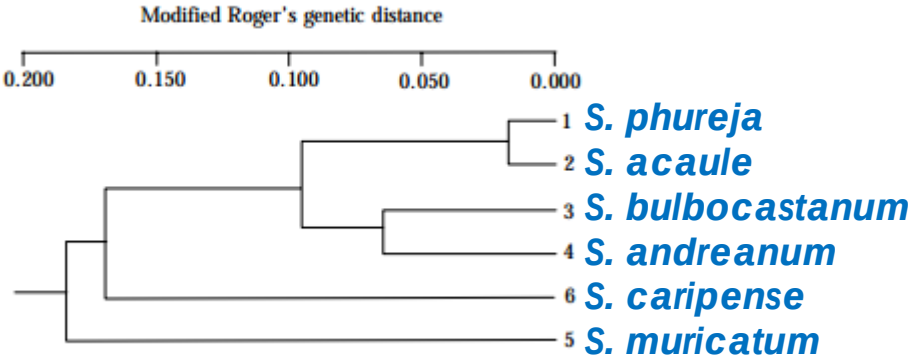
CHARACTERIZATION OF *Phytophthora infestans* (Mont.) De Bary. SUBPOPULATIONS OBTAINED FROM WILD *Solanum* SPECIES

Lozoya et al. Agrociencia, 40: 325-333, Mayo-Junio, 2006.

Table 1. Frequencies of genotypes of *P. infestans* per *Solanum* host.
Cuadro 1. Frecuencia de genotipos de *P. infestans* por hospedante *Solanum*.

Genotype	MT	Gpi	Pep	Number	Frequency (%)	Host species
1	A2	100/100	100/100	9	15.5	*S. phureja, S. acaule*
2	A2	86/100	92/100	4	6.8	*S. phureja, S. caripense*
3	A2	86/122	92/100	4	6.8	*S. phureja, S. caripense*
4	A2	86/100	100/100	4	6.8	*S. phureja, S. acaule, S. caripense*
5	A2	86/122	96/100	2	3.4	*S. phureja, S. acaule*
6†	A2	100/111/122	100/100	1	1.7	*S. phureja*
7	A2	86/86	100/100	1	1.7	*S. acaule*
8	A1	86/100	100/100	6	10.3	*S. phureja, S. acaule, S. bulbocastanum, S. andreanum*
9¶	A1	86/100	92/100	6	10.3	*S. phureja, S. muricatum*
10	A1	100/100	100/100	4	6.8	*S. acaule*
11	A1	86/122	96/100	4	6.8	*S. acaule, S. bulbocastanum*
12	A1	86/122	100/100	3	5.1	*S. phureja, S. acaule*
13†	A1	100/111/122	100/100	2	3.4	*S. phureja*
14	A1	83/100	100/100	1	1.7	*S. phureja*
15	A1	86/100	96/100	1	1.7	*S. bulbocastanum*
16†	A1	100/111/122	92/100	1	1.7	*S. caripense*
17	Hom	86/122	100/100	2	3.4	*S. phureja*
18	Hom	83/100	100/100	2	3.4	*S. acaule*
19	Hom	86/86	100/100	1	1.7	*S. phureja*

† US-8.
¶ US-1.
Hom: homothallic.



Lozoya et al. Agrociencia, 40: 325-333, Mayo-Junio, 2006.

Host of *Phytophthora infestans* (Pi), *P. andina* (Pa) and another non classified isolates (U) report by 7 countries in S. America

	CO	VE	BO	EC	PE	AR	CH
Cultivated Taxa							
Tuber bearing[1]	Pi	Pi	Pi	Pi	Pi	Pi	Pi
S. betaceum	Pi/Pa/U			Pa	Pa		
S. quitoense	Pi	Pi		Pa/Pi			
Physalis peruviana	Pi						
S. muricatum	Pi			Pi/Pa[2]	Pi		
S. lycopersicum	Pi	Pi	Pi	Pi	Pi	Pi	Pi
Wild taxa							
Tuber bearing	Pi			Pi	Pi		
S. caripense	Pi			Pi	Pi		
S. juglandifolium, S. ochrantum	Pi,			Pi/U			
Solanum section Anarrhichomenum				Pa			
S. marginatum	Pi						
S. hispidum				Pa			
Datura stramonium	Pi						
Brugmansia spp[3]				Pa			

1- Solanum chaucha, Solanum tuberosum ssp. *andigena*, *Solanum phureja*, *Solanum goniocalyx, Solanum stenotomum*, *Solanum hygrothermicum*, *Solanum ajanhuiri* and *Solanum juzepczukii*, *Solanum curtilobum*

2- *P. andina* was found attacking *S. muricatum* in one field but across two consecutive seasons (Adler, Chacón, Flier, & Forbes, 2002, p. 2); no other reports are known.

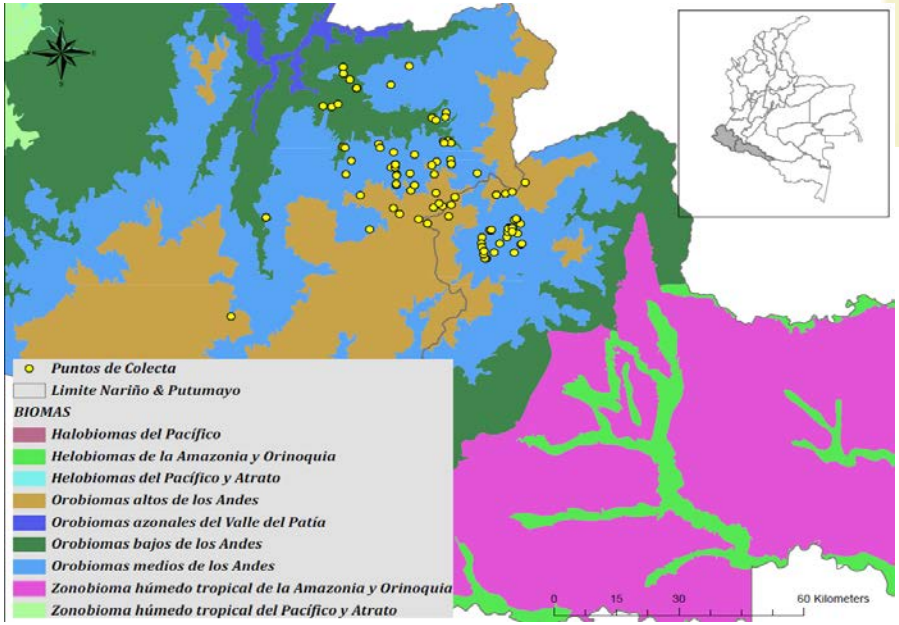
3- Only on flower petals

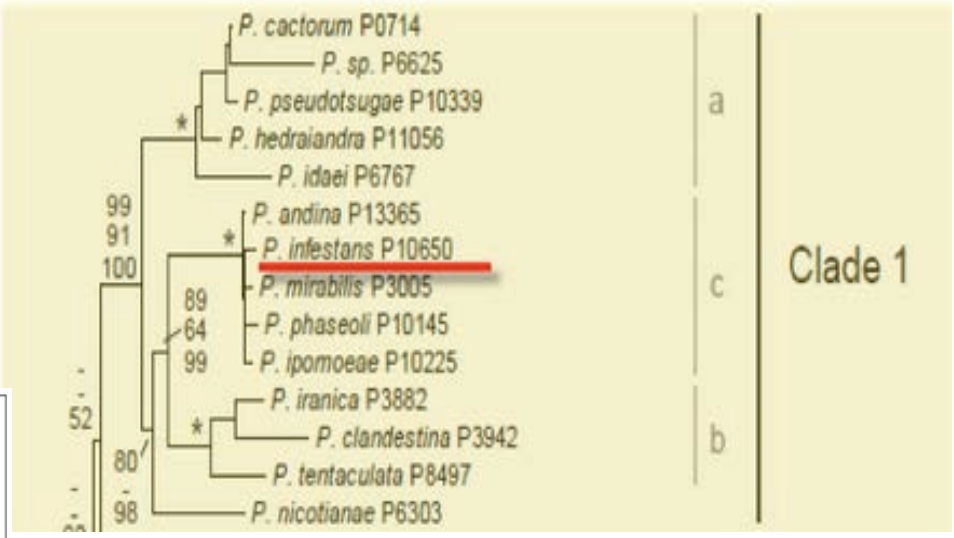
4. *Solanum melongena* in Argentina

Isolated from Tree tomato (*Solanum betaceum) at* Nariño and Putumayo departments, Colombia.

Pit

Aislamientos de *P. infestans* de tomate de árbol N=120



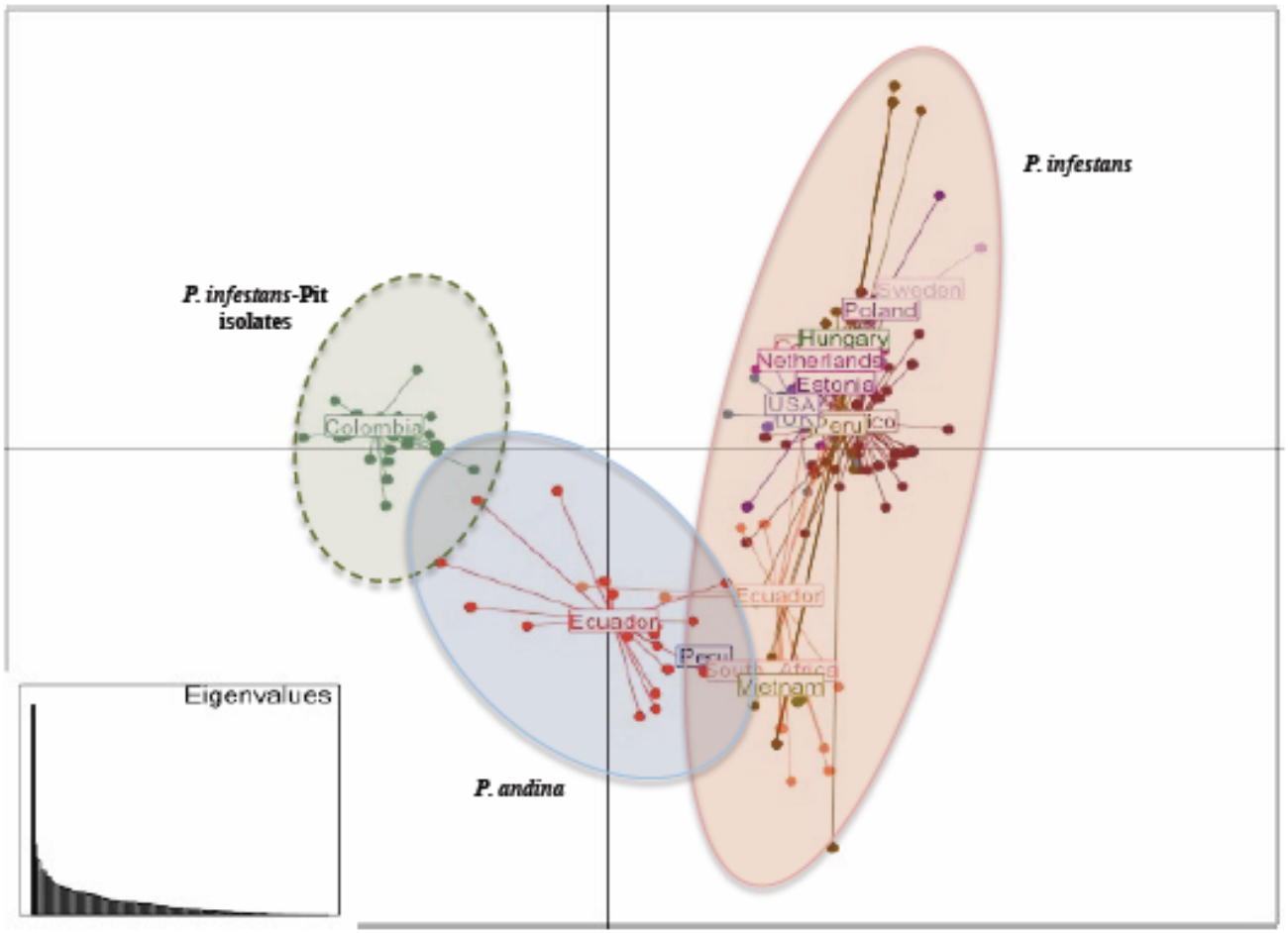


Aislamientos de referencia

- *P. infestans* **(Pi)**
- *P. andina* (Ecuador – Perú) **(Pa)**
- *P. mirabilis* **(Pm)**
- *P. ipomoeae* **(Po)**
- *P. phaseoli* **(Pp)**

Restrepo, S. 2014, ALAP, Bogotá, Colombia

Principal components analysis
11 SSRs, 277 isolates



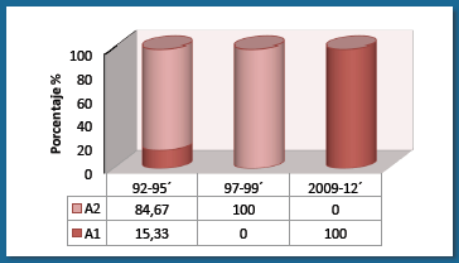
Restrepo, S. 2014, ALAP, Bogota,Colombia

Late blight on potato in Peru

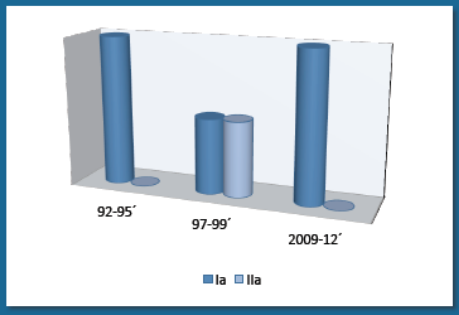
	Phytophthora infestans
Areas	**Costa, Sierra, Ceja de selva**
Altitude	**125-4225 msl**
Host	**Potato, tomato, sweet cucumber and 47 other wild species (*Solanum, Lycopersicum, Nolana*)**
Mating type	**A1**
Fungicide resistance	**Metalaxyl resistance**
Lineages	**US1, PE-3, PE-5, PE-6 and PE-7**
Effector allelic for Ipi0	**Ipi01, ipi02,ipi03 and ipi04**

Perez, W. 2014. ALAP, Bogota, Colombia

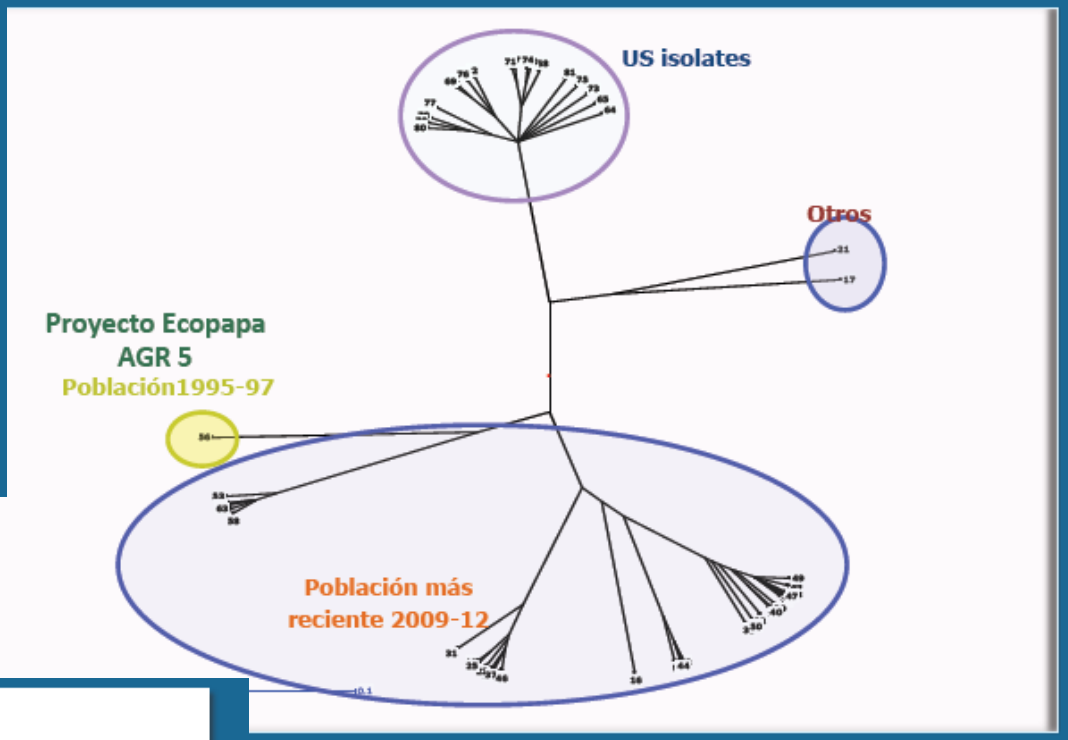
Argentina situation

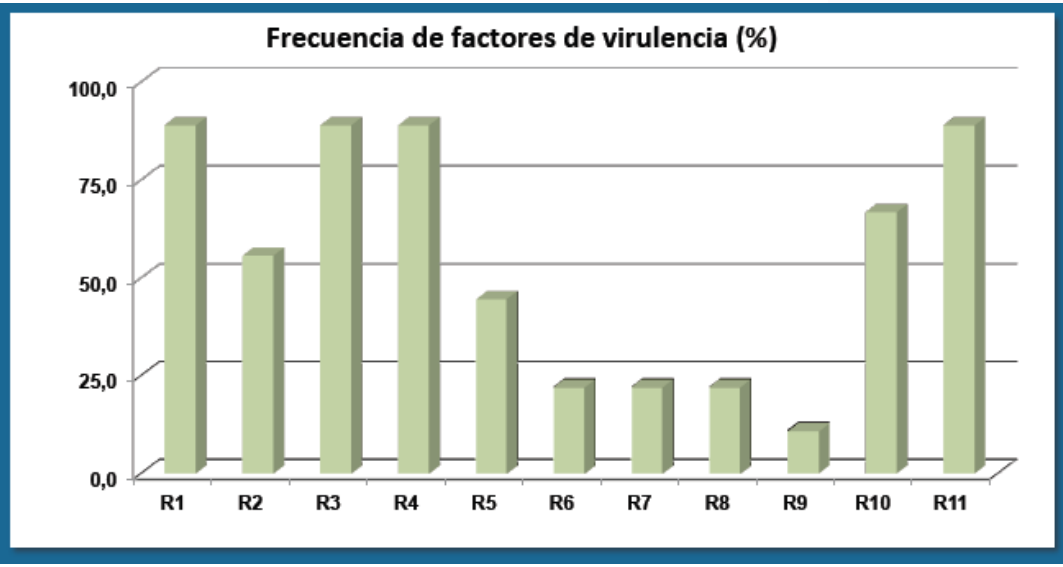


Maiting type



Haplotipo mitocondrial

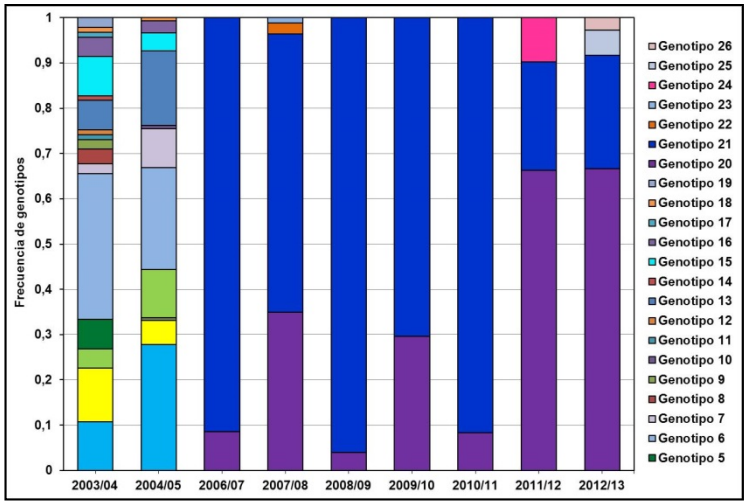




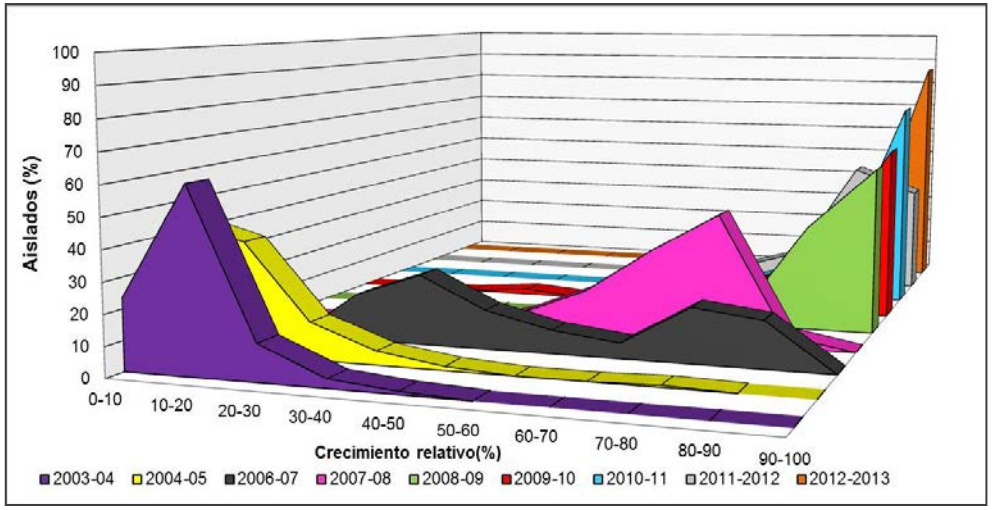
2009-1014: 2_A1

Lucca, F. INTA, Argentina

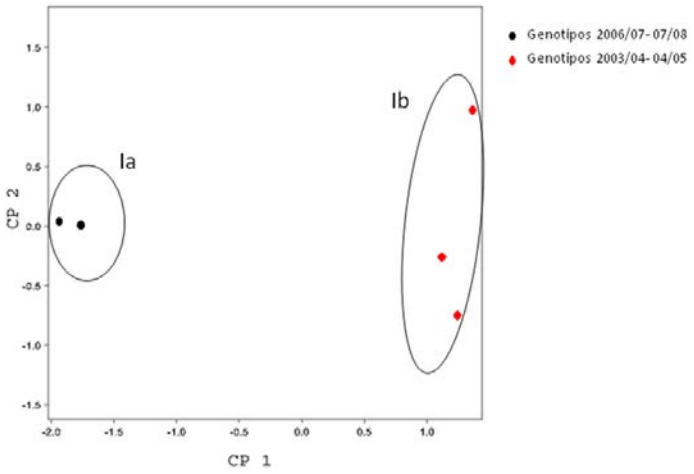
P. infestans characterization in Chile



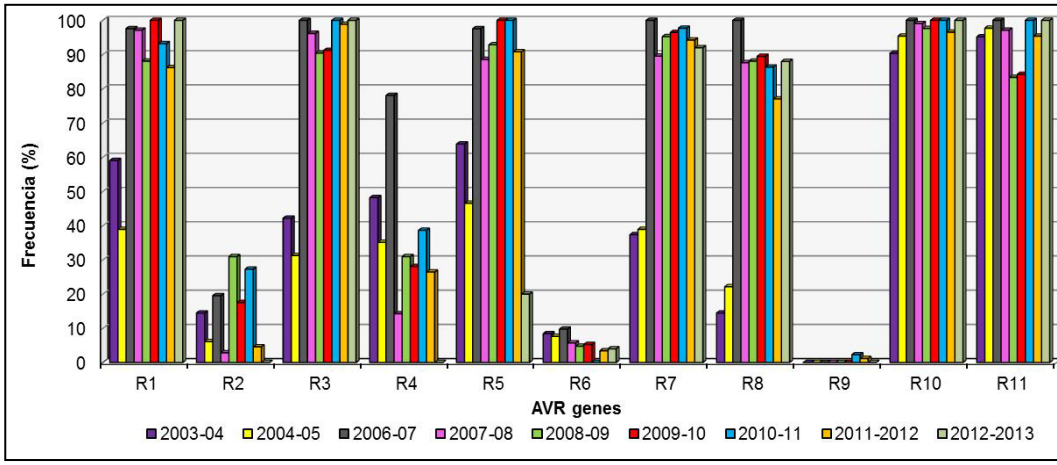
Genotype frequency (9 SSR)



Methalaxil resistance



MtDNA analysis



AVR genes

Cuantitative resistance in wild potato species (Perú)

S. albicans, S. alandiae, S. ambusinum, S. circaeifolium, S. chiquidenum, S. cajamarquense, S. toralapanum, S. commersonii, S. coelestipetalum, S. huancabambense, S. megistacrolobum, S. microdontum, S. multiinterruptum, y S. sogorandinum

Cualitative resistance in wild potato species (Perú)

S. piurae , S. circaeifolium, S. hougasii, S. fendleri, S. cardiophyllum, S. iopetalum .

Non specific resistance and/or R genes (Bolivia)

Solanum andigena
S. tuberosum
S. x juzepczukii
S. x ajanhuiri
S. stenotomum
S. phureja

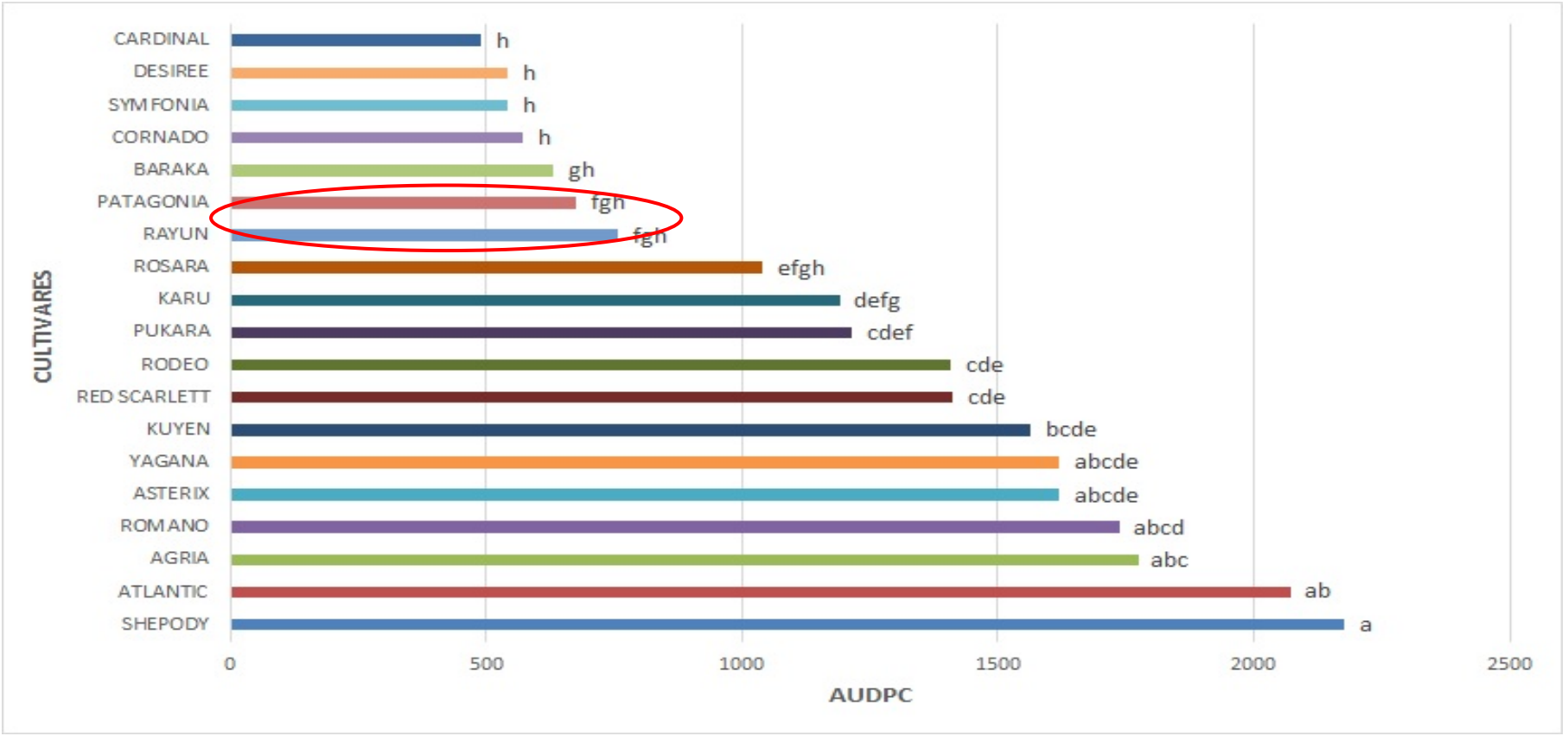
Gabriel et al (2007) Euphytica 153: 321-328
Coca y Tolín (2013) Am. J. Plant Sci. 4: 53-58
Gabriel J et al (2013) Rev Latinoam papa 17 (2): 131-142.

Non specific resistance and R genes (Bolivia)

S. okadae,
S. bukasovii,
S. toralapanum
S. acaule
S. circaeifolium
S. circaeifolium var. capsicibaccatum
S. sparsipilum
S. berthaultii
S. poliadenium

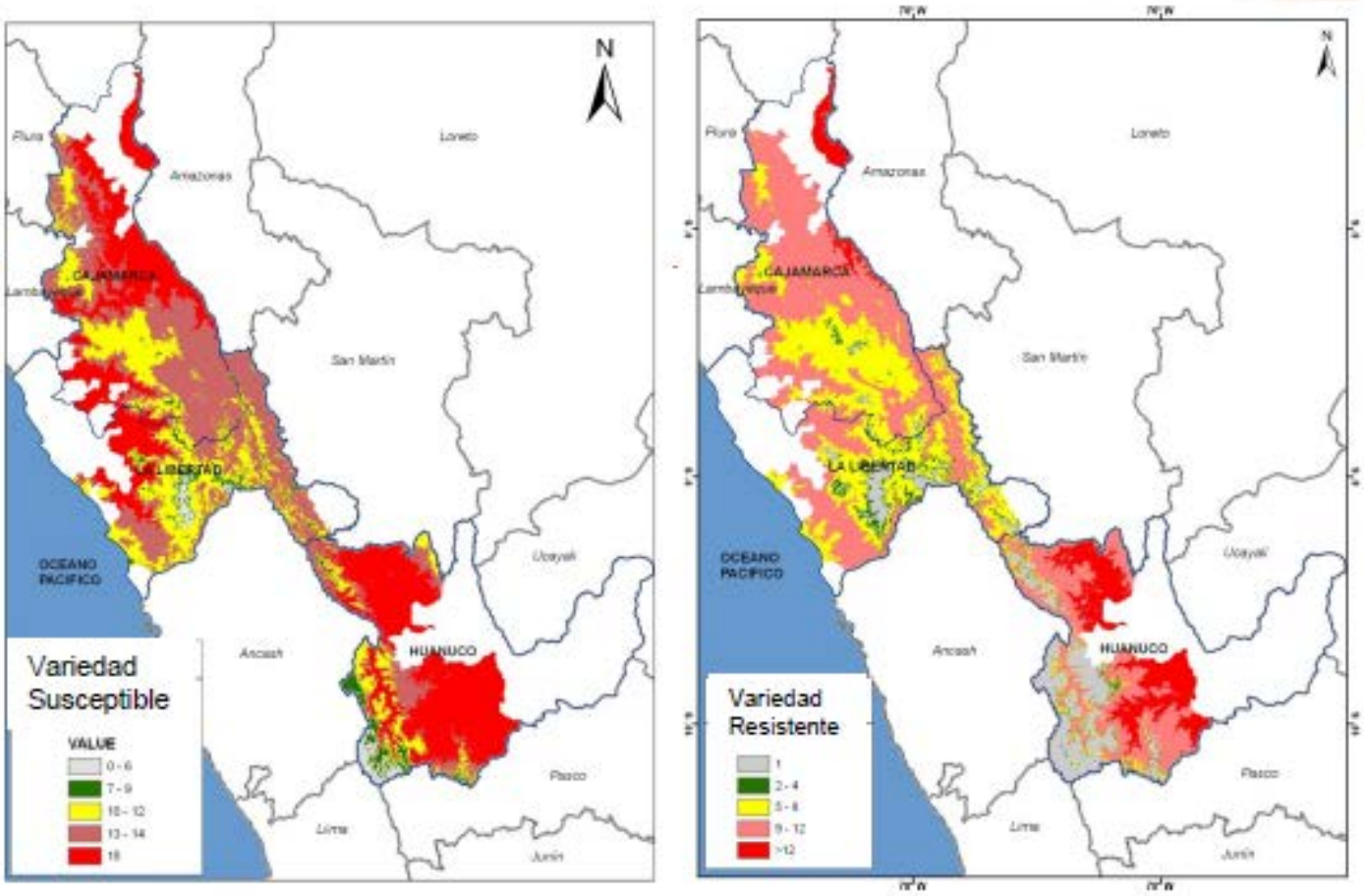
Gabriel et al (2011) Span J Agr Res 9 (1): 193-197
Colque et al (2011) Rev Agricultura 50: 18 – 26.
Coca y Monetalegre (2006) Span J Agr Res 4(2): 156-160

Variety resistance to Late blight in Chile



- **INIA breeding program (Patagonia, Rayun).**
- **Introduction of R genes from *S. demissum* using the differentials from Mastembroek and Black series.**
- **Characterization for disease resistance of *landraces potatoes from Chiloé.* Chile is the center of origin of *S. tuberosum Chilotanum* group, which has been the basis of improved varieties available around the world**

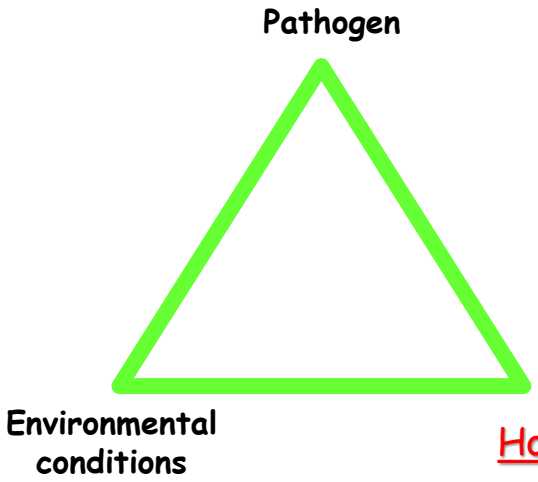
Uso de GEOSIMCAST

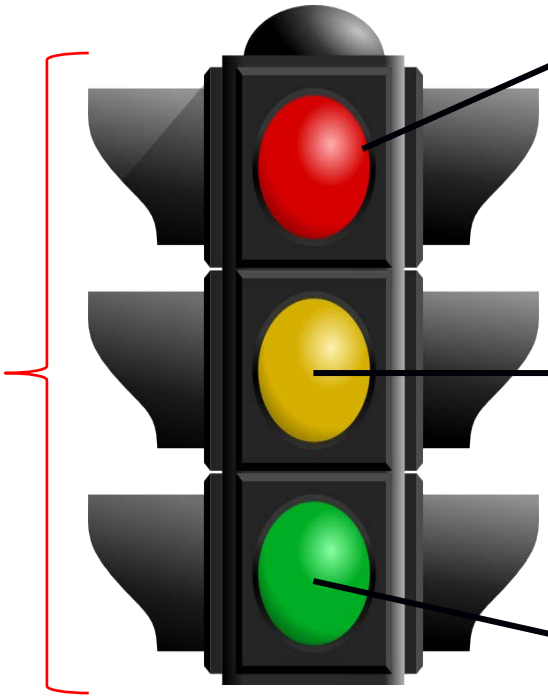


Giraldo, D. ,et. al, 2010

Use of resistant varieties and its relation with the number of fungicide sprays according to GEOSIMCAST monitoring

Simple tool as DSS according to variety in Peru and Bolivia

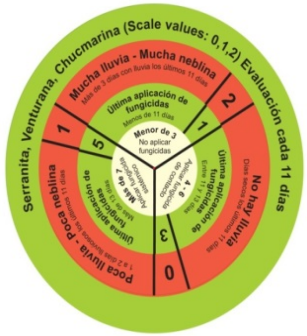




Traffic light

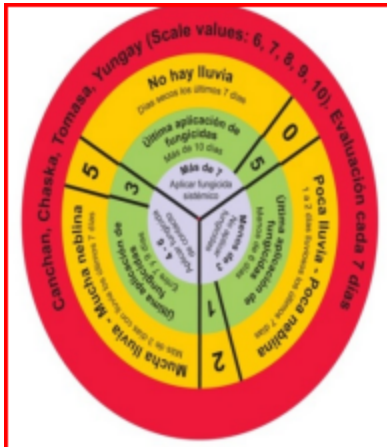
Susceptible
(Score 6 a 9)

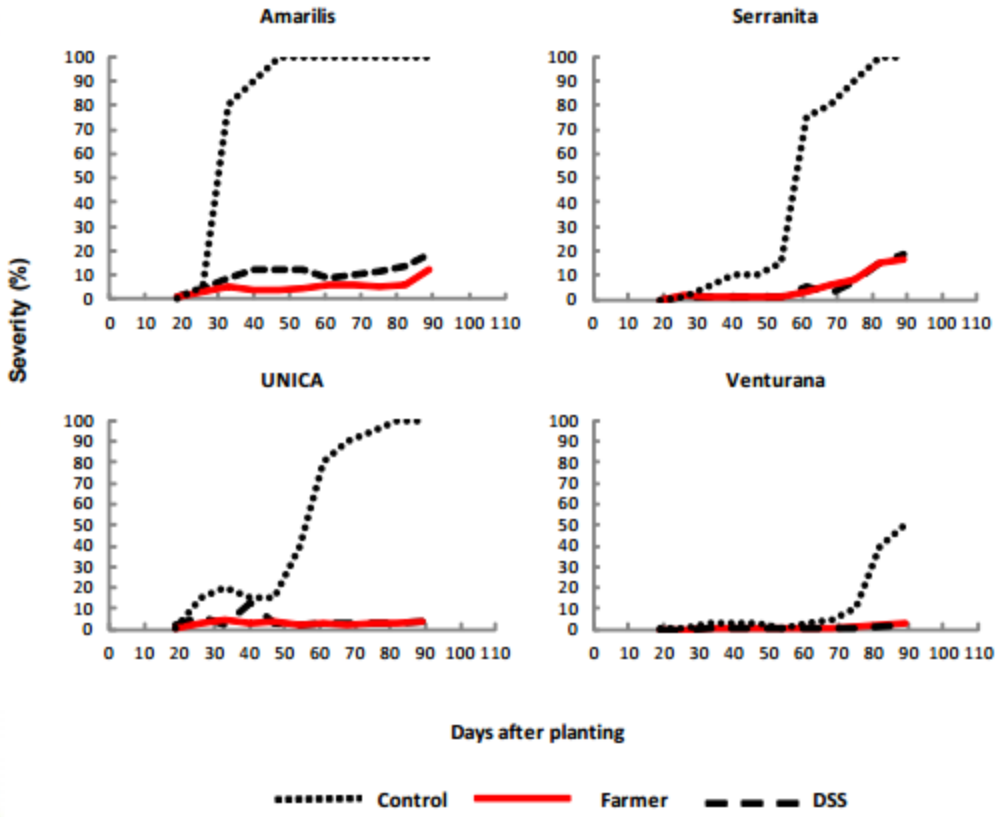
Moderad.
resistant
(Score 3 a 5)



Resistant
(Score 0 a 2)

Perez, W. 2014. ALAP, Bogota, Colombia.





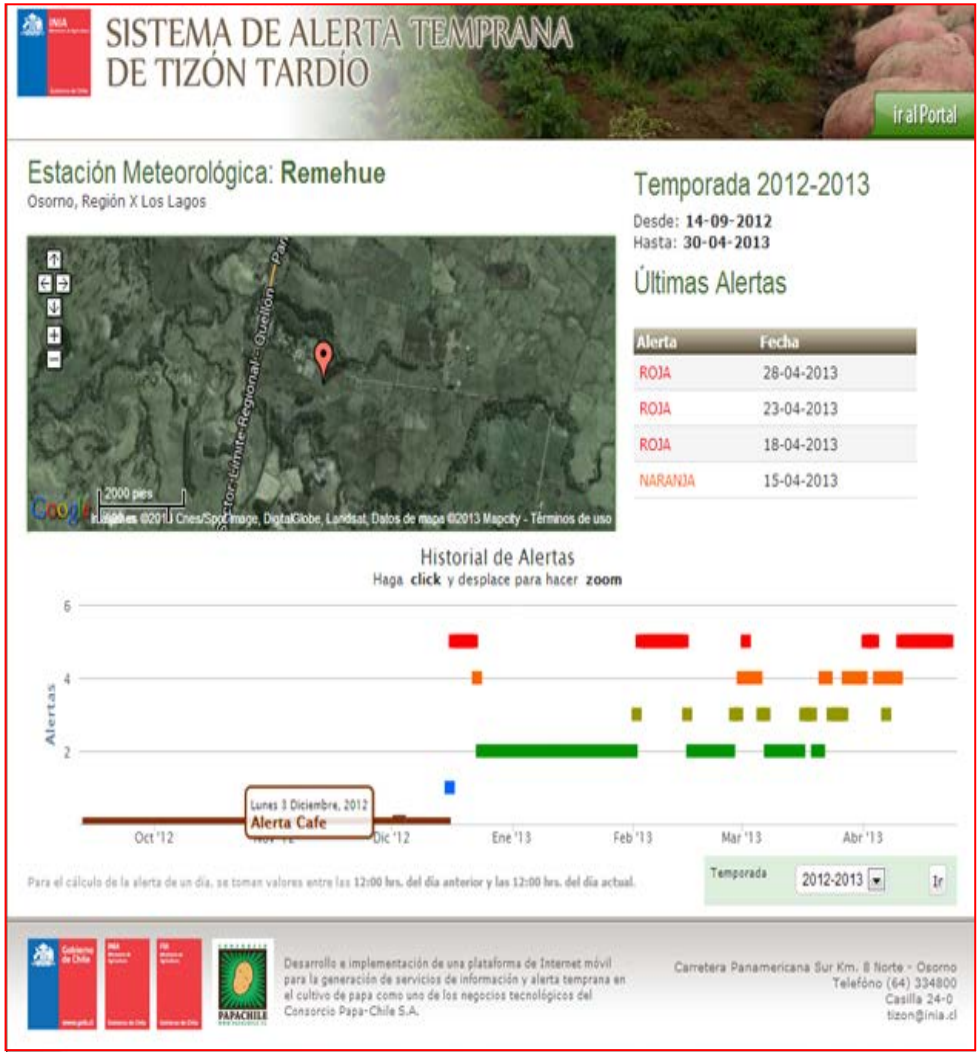
Save 1 to 4 sprays

DSS in Argentina

- Phytoalert ®
- Condition based in Simcast and fungicide
- INTA Argentina
- Southeast of Buenos Aires province
- Working in cooperation with WUR and Mc Cain
- Other potato farmers
- Reduction in spray per season (40%)
- Reduction in EIQ

Late blight DSS Chile

http://tizon.inia.cl, email, SMS

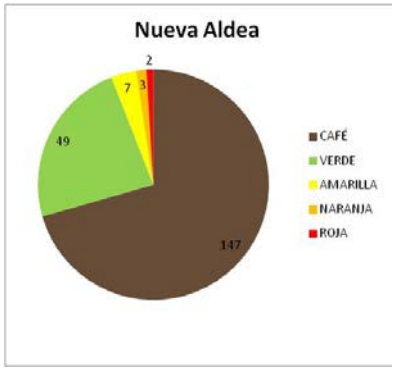


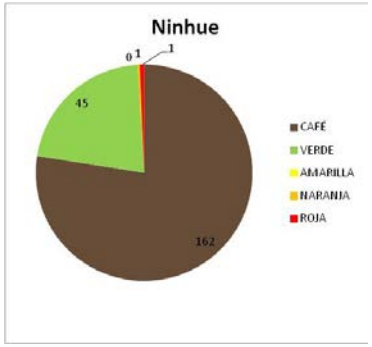
Weather station network

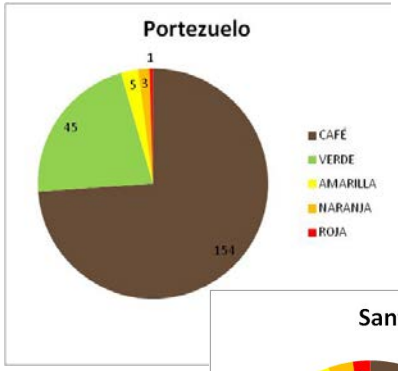
Significado Íconos

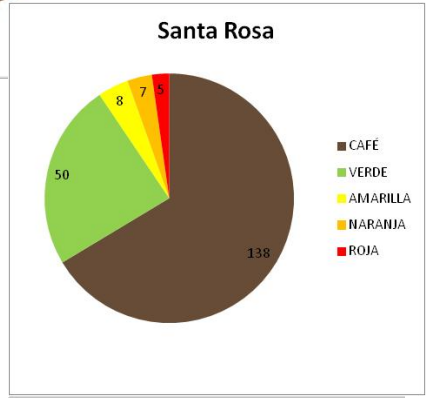
- Periodo desde emergencia del cultivo hasta la primera alerta
- Primera alerta de la temporada
- Día sin condiciones para el desarrollo de tizón tardío
- Revisar condiciones en los próximos tres días
- Condiciones medias para el desarrollo de tizón tardáo
- Condiciones altas para el desarrollo de tizón tardío
- ESTACIÓN TEMPORALMENTE CON DATOS SIN CALCULAR

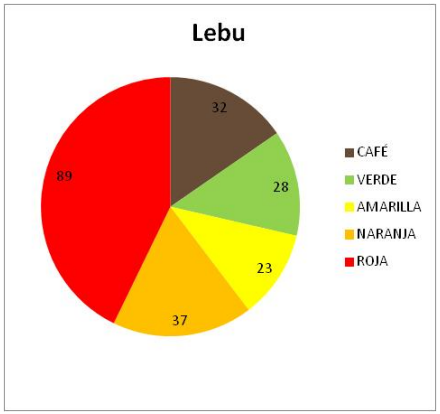
Late blight historic situation

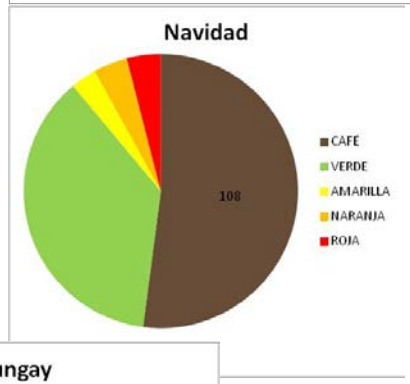


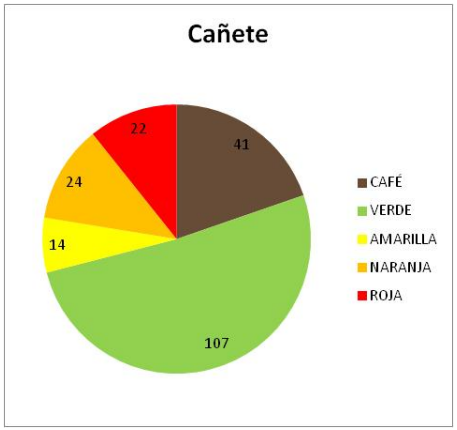


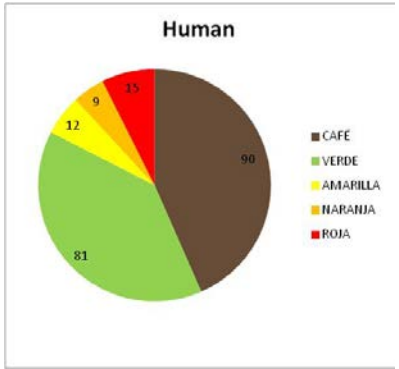


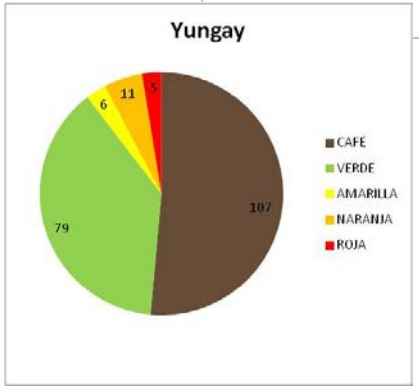












Fungicide evaluation

- Strategy according to fungicide, plant development and DSS.
- Fungicide evaluation for efficacy, residuality and EC50
- Fungicides:

- **Metalaxil + Mancozeb (Ridomil)**
- **Mefenoxam + Clorotalonil (Folio gold)**
- **Propamocarb + fluopicolide (Infinito)**
- **Propamocarb +Fenamidona (Consento)**
- **Dimetomorfo (Forum)**
- **Cimoxanilo + Mancozeb (Curzate)**
- **Famoxadona + Cimoxanilo (Equation pro)**
- **Ciazofamida (Ranman)**
- **Ametoctradina + Dimetomorfo (Zampros)**
- **Mandipropamide (Revus)**
- **Mandipropamide +Difeconazole (Revus top)**
- **Fluazinam (Shirlan)**

- **Oxathiapiprolin**
- **Amisulbrom**
- **Benthiavalicarb**

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Tizon Latino Network

- TizonLatino was formed in September 2014 at the Latin America Potato Association meeting (ALAP) in Bogota, Colombia. It was born from the need to work together on a disease and hosts originating in Latin America, which causes serious losses and affects the food security of the region. Today, ten Latin American countries are part of this network.

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TizonLatino approach will be:

- **Monitoring and characterization of pathogens.**
- **Study the effects of late blight on potato landraces due to climate change and its impact on diversity and food security.**
- **Search for durable resistance and breeding populations.**
- **Develop integrated pest management strategies using decision support systems, fungicides and resistant cultivars.**
- **Extension and technology transfer focusing on the development and implementation of management strategies, based on vulnerability and food security in Latin America and for adaptation to climate change.**

Additional information can be found in the Tizon Latino website:
https://tizonlatino.wordpress.com

Thank you…