International Quinoa Conference 2016:

Quinoa for Future Food and Nutrition Security in Marginal Environments

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www.quinoaconference.com

Quinoa research and development for lowland environments in South America

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Main institutions related to quinoa R&D in the Lowlands

Embrapa Brazilia + Univ of Brazilia
Breeding, adaptation to tropical environments
Agronomic Management

Miguel Lillo Inst. (Tucuman)
Salinity and water stress
Nutritional Eval., UV-B responses
Betalaines (pigments)

CEAZA La Serena /INIA
Germplasm evaluation
Salinity and water stress
Universidad de Chile
Salinity responses, Archaeology
University of Concepción
N responses, Water deficits

INIA-Uruguay
Germplasm Evaluation

University of Buenos Aires & INTA
Seed and Crop Physiology
Germplasm Evaluation

Univ Austral (Valdivia)
Temperature responses
Agrogen (Temuco)
Breeding
CET (Temuco)
Small farmers

INTA Ascasubi (Patagonia)
Germplasm evaluation
Agronomy, commercial production

ROAD MAP

Subjects included in this talk

Germplasm collection and characterization/evaluation

- Chile and Argentina

Seed Science

- Seed Aging
- Seed dormancy and pre-harvest sprouting resistance

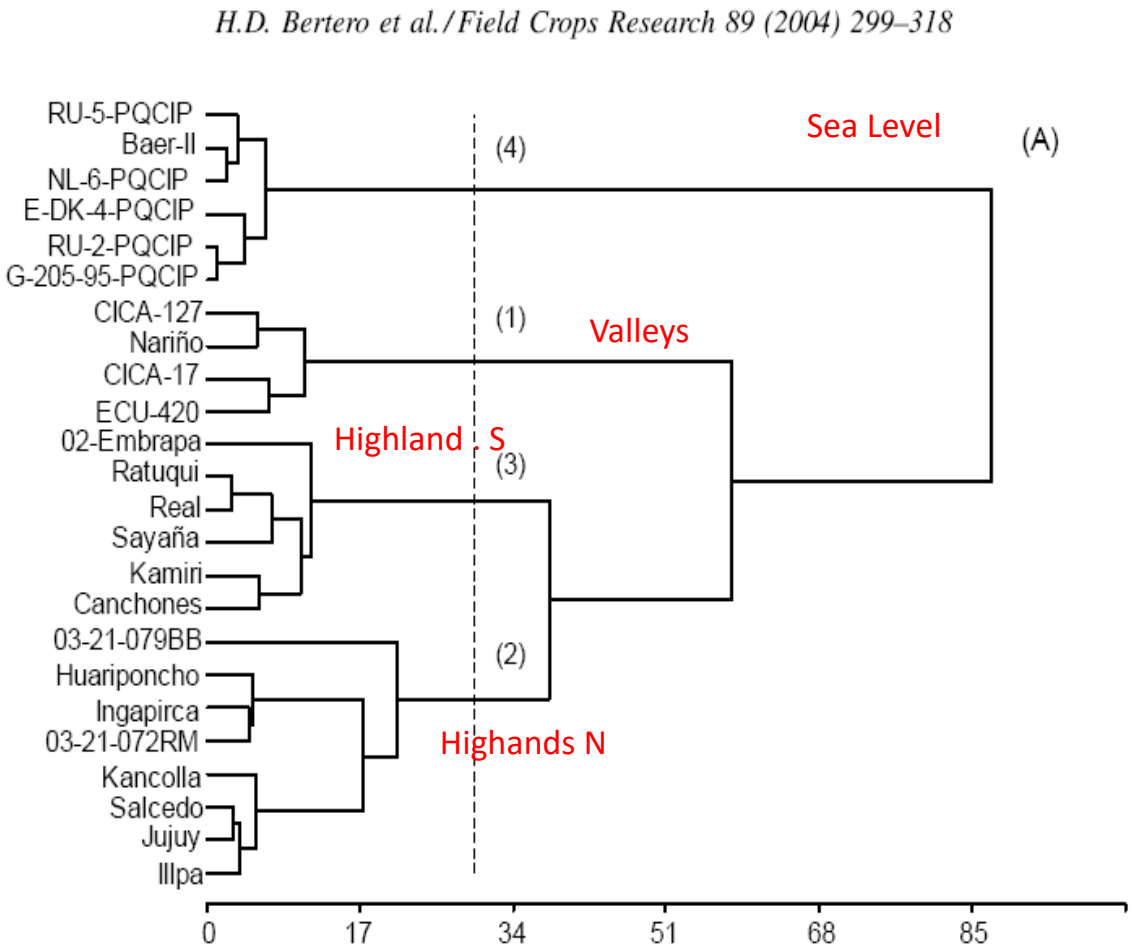
Crop Science

- Yield and seed number determination
- Stress responses: water stress, salinity stress

Agronomic Evaluation and Breeding

QUINOA GERMPLASM-GENETIC STRUCTURE

Genotype x Environment Interaction patterns for yield distinguish four genetic groups related to environments of origin and confirm previous ideotype classification



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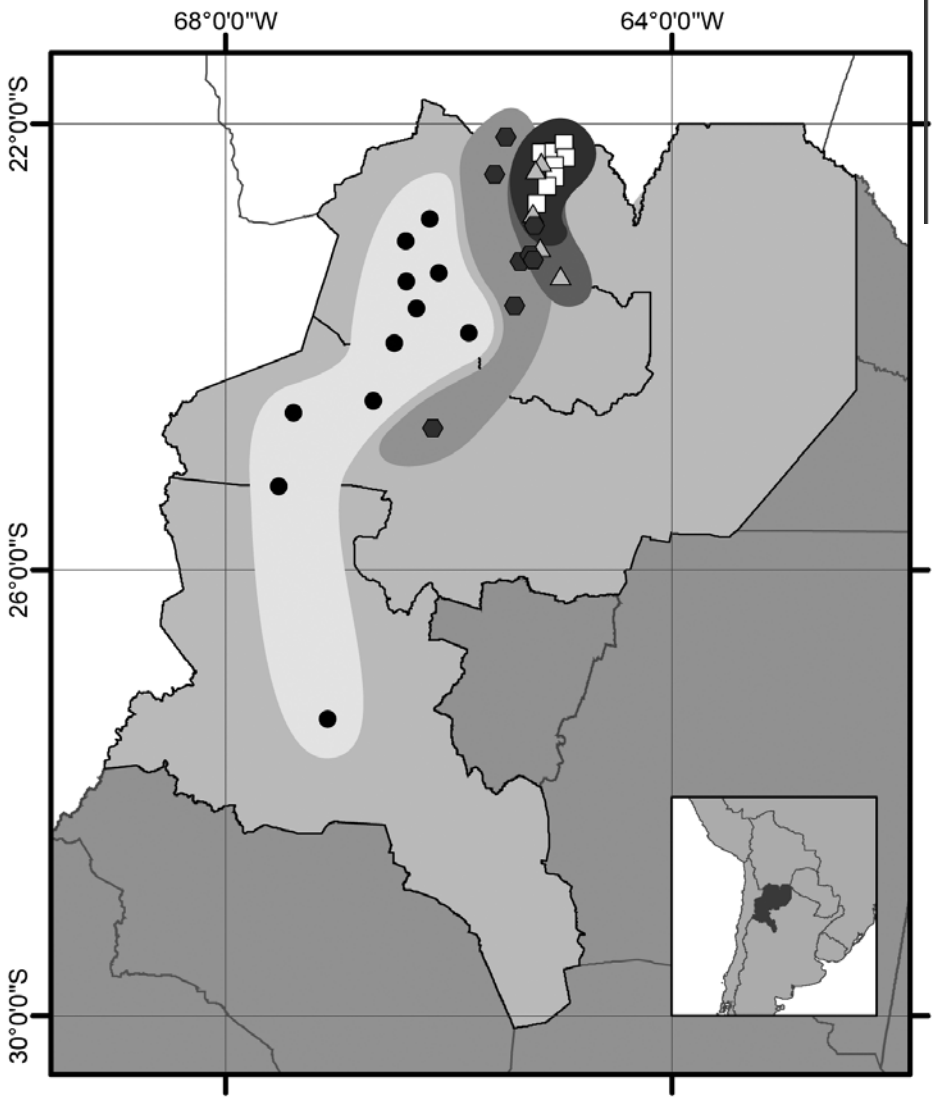
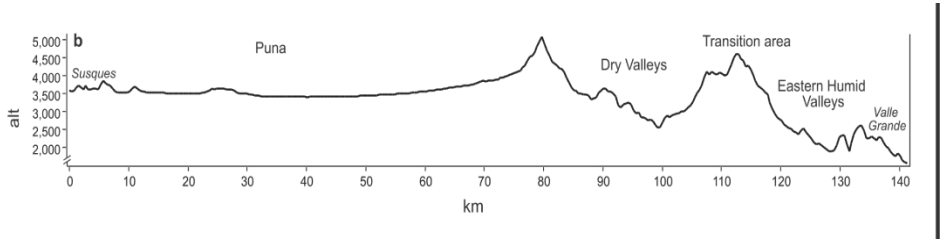
QUINOA GERMPLASM-ARGENTINA





There are four genetic groups (based on SSR variation) in Northwest Argentina, structured according to four environments of origin:

- Dry Highlands
- Dry valleys
- Humid valleys
- Humid highlands

~ 90 native accessions are conserved in the National Gerrmplasm Bank

Some of these varieties are being selected for mountain environments in NWA, not tried yet at low altitudes

Costa Tártara et al. 2012. Cons. Gen. 13: 1027-1038

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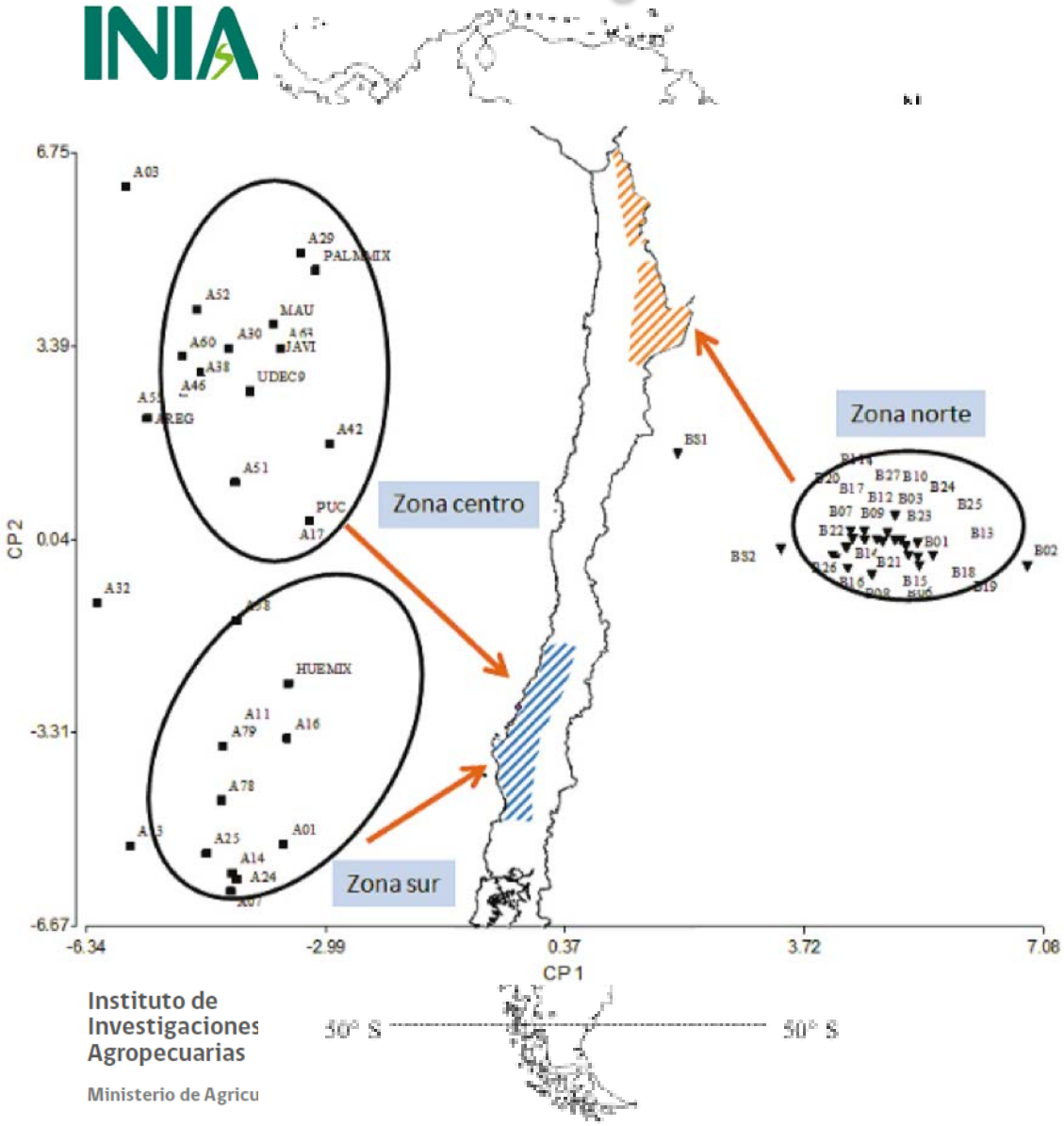
Quinoa Ecotypes distribution according to diversity origin sub-centers in South América



1. Inter-Andean valley;
2. Altiplano;
3. Yungas;
4. Salares
5. Coastal/Lowlands).

Macro-zones of quinoa culture in Chile

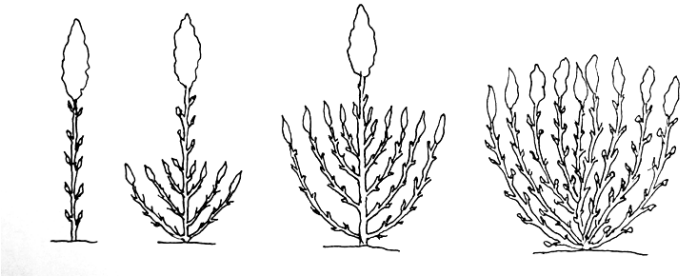
A. North, Salares
B. Central
C. South

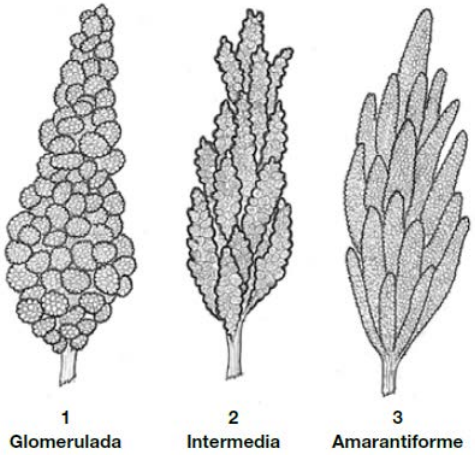
Adapted from Fuentes et al. 2009 Cons. Genet. 10: 369-377

Characterization of selected lines grown in arid zones, from National Seed Bank Collection

Red de Bancos de Germoplasma
Banco Base Vicuña

- Morphometric traits
- Phenology
- Growth Habit
- Branching
- Plant height
- Inflorescence traits
- Productivity:
  - Seeds/plant (gr.)
  - Seed diameter (mm)
  - 1.000 seeds weight (gr.)

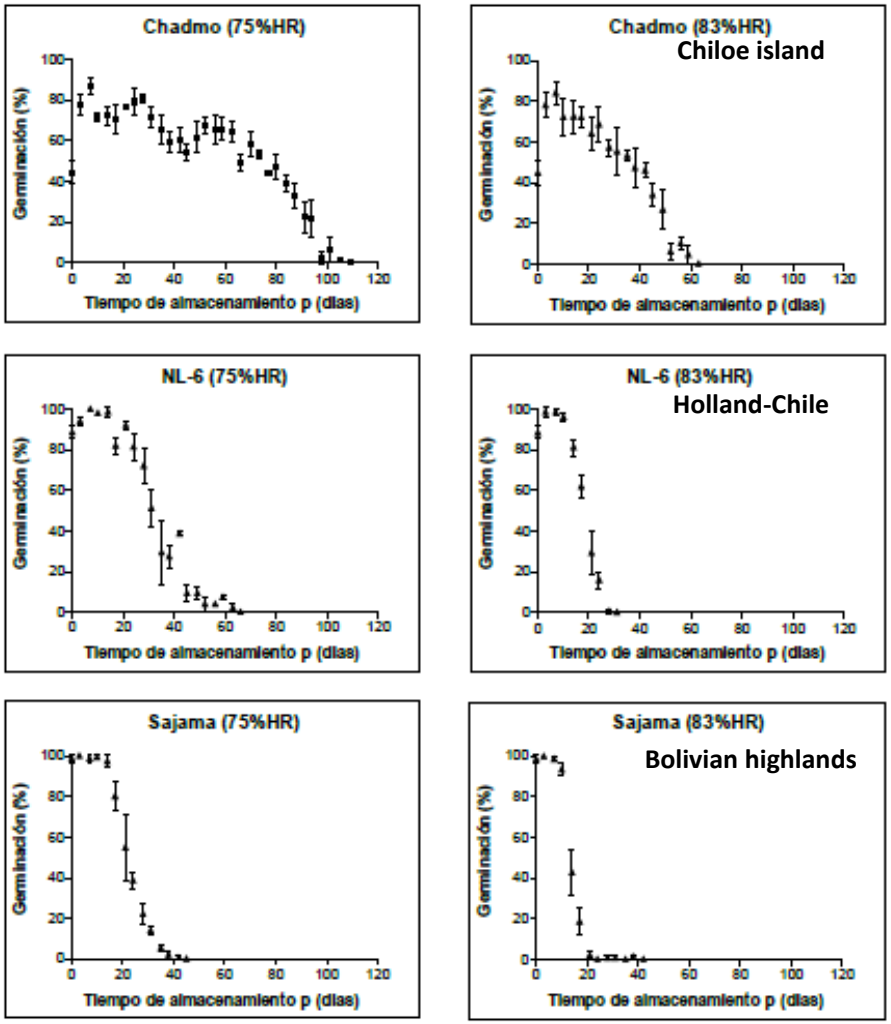




Descriptores para
Quinua
y sus parientes silvestres

SEED SCIENCE- AGING

Variability in seed viability loss



Factors affecting aging:
formation of Maillard products
(protein insolubilization). Reversible by priming
Membranes remain stable
Degree of water mobility
DNA stability ?
Organelles integrity ?

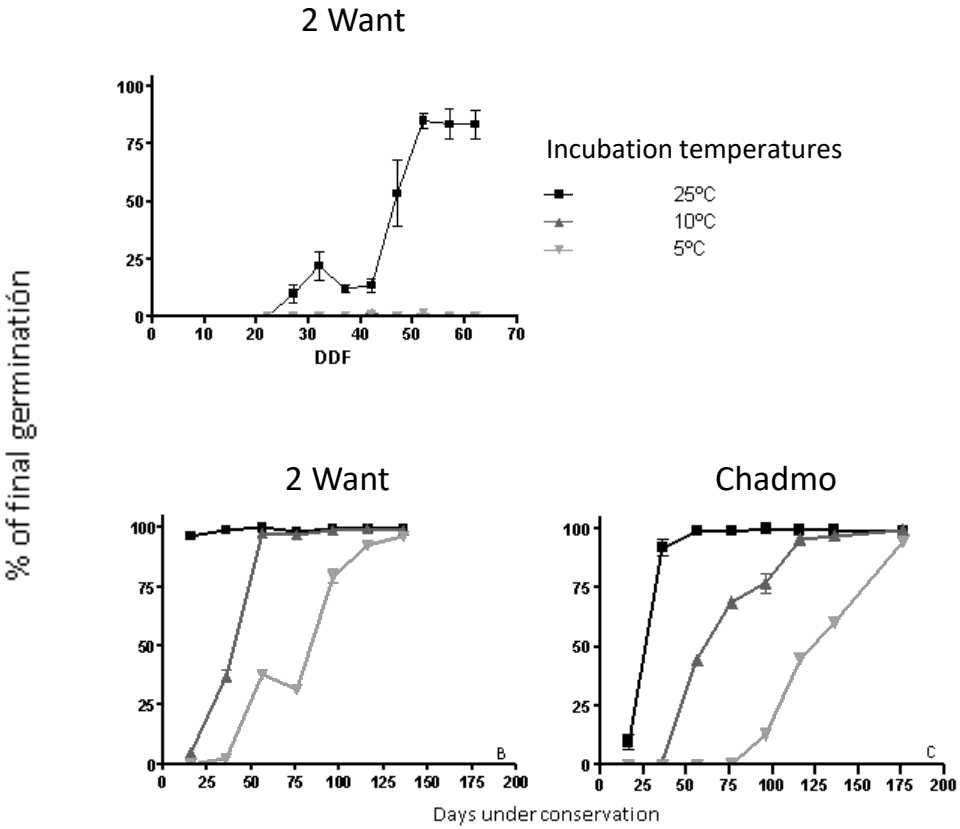
Castellion. 2008. Ph D Thesis
Castellion et al. 2010. Food Chem. 121: 952-958

Dept. of Biodiversity and Exp. Biol. UBA

An accession from Chiloé (Chile) has a much lower deterioration rate

SEED SCIENCE
DORMANCY AND PREHARVEST SPROUTING RESISTANCE

Two quinoa accessions exhibiting dormancy at harvest were identified



HIGHER DORMANCY WHEN SEEDS GROW UNDER LONG DAYS AND HIGH TEMPERATURES

LATE SPRING SOWING

Ceccato et al. 2011. Seed Sci. Res. 21: 133-141

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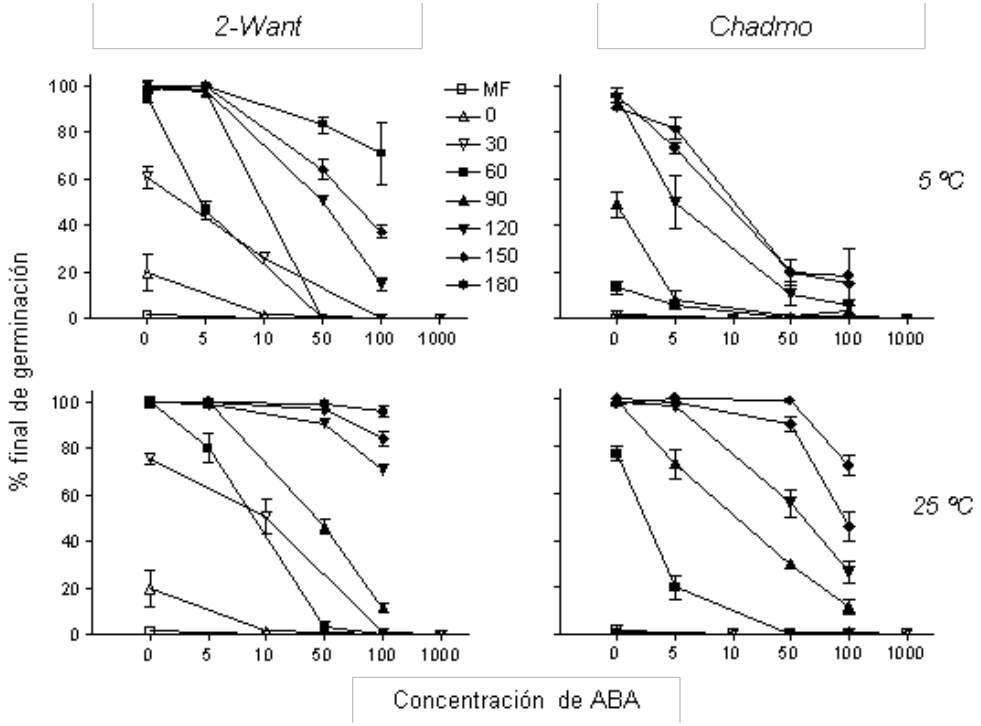
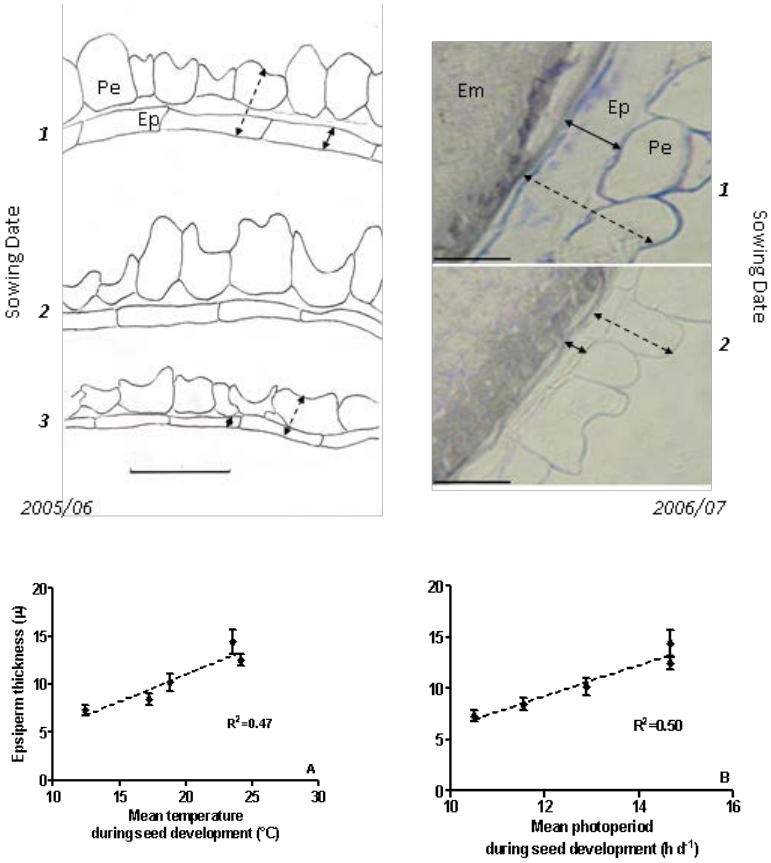
SEED SCIENCE-DORMANCY AND PHS RESISTANCE

Factors involved in dormancy release in two potential sources of PHS resistance



Changes in ABA sensitivity with time under conservation



Changes in episperm thickness (sowing date)

Higher Abcisic Acid sensitivity and episperm thickness are associated with more dormant seeds

Ceccato et al. 2015. Seed Sci. Res. 25: 267-275
Ceccato, D. unpublished

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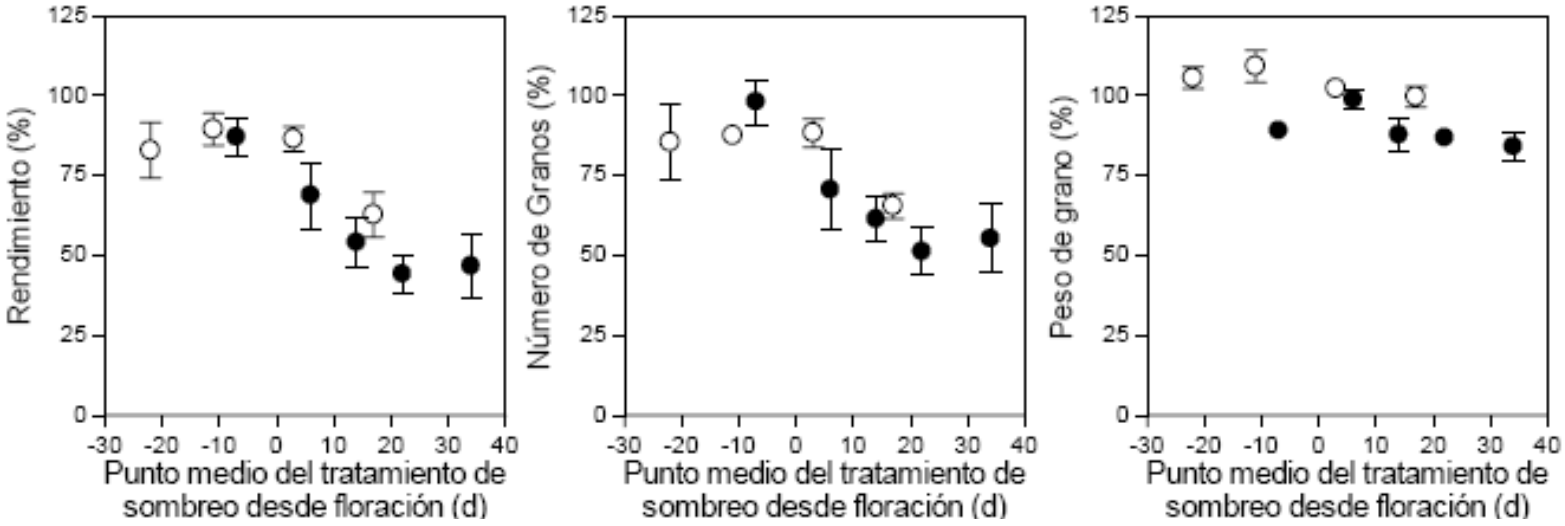
CROP SCIENCE- CRITICAL PERIOD FOR YIELD DETERMINATION

Yield | Seed Number | Seed weight

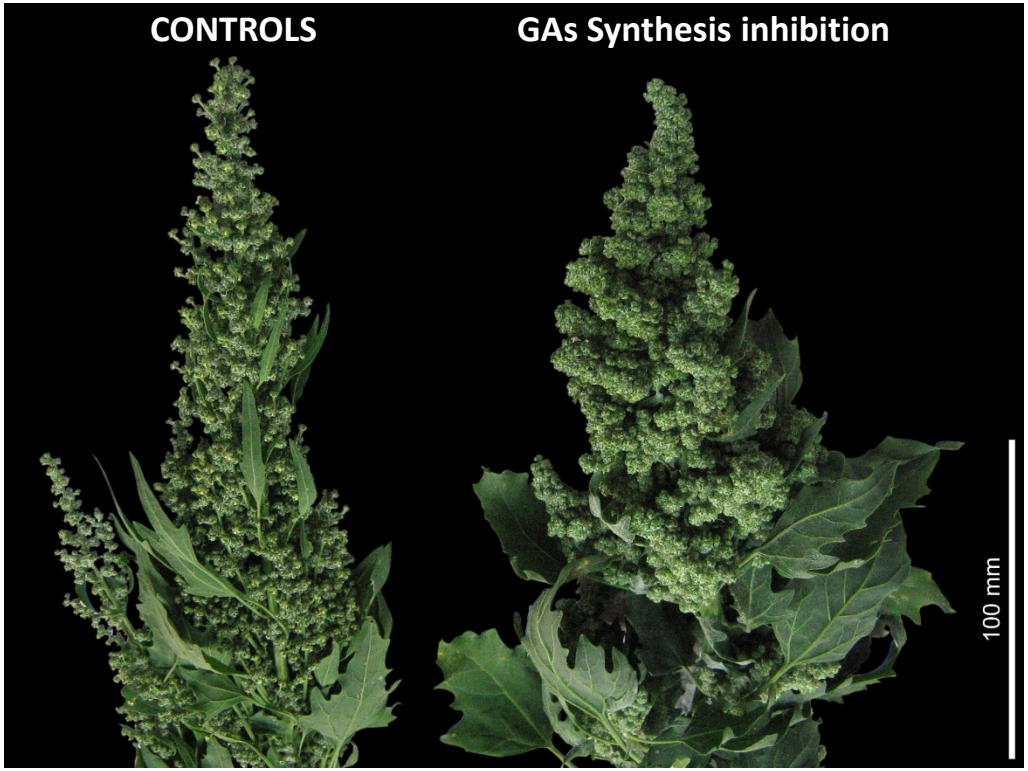


Manipulation of radiation received by the crop (shading). Zero in the x axes indicates the date of flowering (1st anthesis). CV NL-6

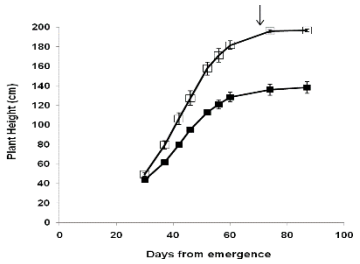
The critical period starts at 1st antesis and extends well into seed filling. Seed number is sensitive to environment during the whole period

Mignone et. al., 2008. Reunión Argentina de Fisiología Vegetal

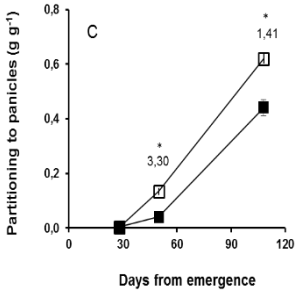
CROP SCIENCE- MANIPULATION OF GIBERELLIC ACID METABOLISM



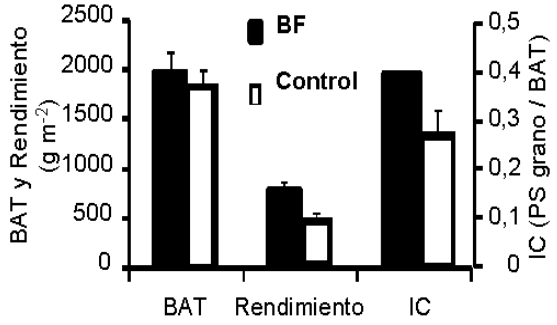
Plant height



Partition to panicles



Yield components



Manipulation of GA synthesis during panicle growth increased yield (trough changes in partition to the panicle and stem and higher harvest índices) by up to 50 %

Gómez et al. 2011. Funct Plant Biol. 38: 420-430

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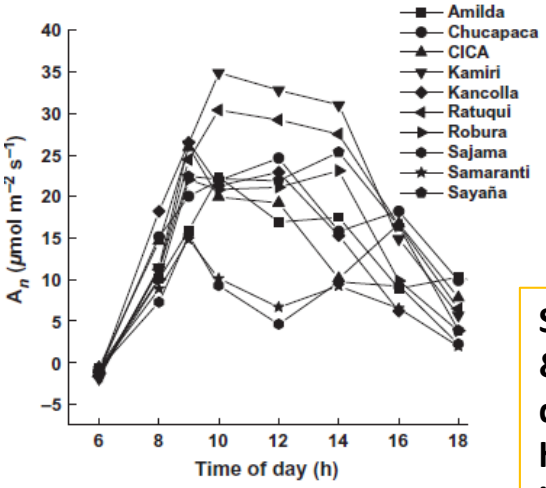
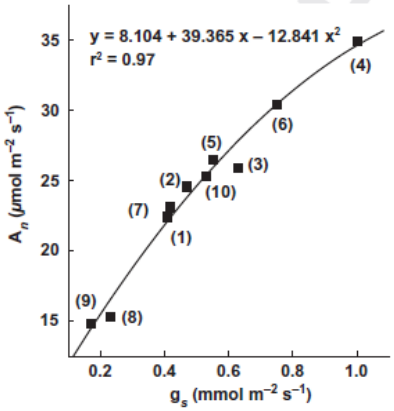
CROP SCIENCE- SALINITY RESPONSES

- Salinity is the subject most covered by physiological research in quinoa
- In a review about salinity tolerance mechanisms in quinoa by Adolf et al. 2013 (Env. & Exp. Bot. 92: 43-54) **~ 40 % of quinoa references have Chilean or Argentinian authors**.
- Research covered germination (including metabolic associated changes) and seedling responses to salinity, osmotic adjustment, osmoprotection, K+ retention and induction of dehydrin accumulation by salinity
- Genetic variation in tolerance and mechanisms involved in Chilean germplasms, including expression of sodium transporter genes CqSOS1 and CqNHX
- **Central questions**: how to deal with **trade-offs** between yield potential and salinity tolerance. Some “sensible genotypes” have higher yields even under high salinity.
- **Good News**: a growing number or articles include evaluations at different hierarchical level (crop physiology, cellular processes, gene expression).

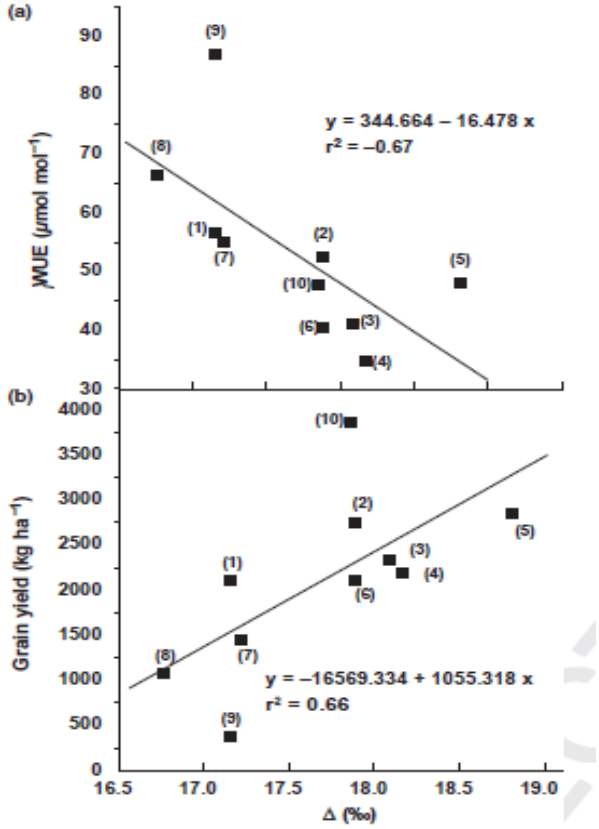
CROP SCIENCE- WATER DEFICIT

CARBON ASSIMILATION, CONDUCTANCE, WUE & C ISOTOPE DISCRIMINATION under moderate deficit





Sustaining assimilation & water use under water deficits is associated with higher yields. Carbon isotope discrimination was positively related to yield



Gonzalez et al. 2010. J Agr. Crop Sci.

Miguel Lillo Institute, Tucumán, Argentina

CROP SCIENCE- AGRONOMIC EVALUATIONS

Variety selection and comercial production in South and South East Buenos Aires province

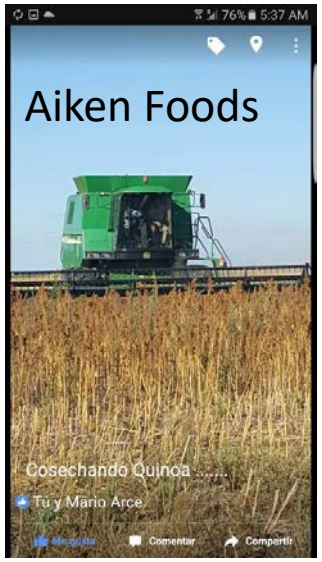
Variety evaluation (2006-2012)

Selection

Seed processing plant

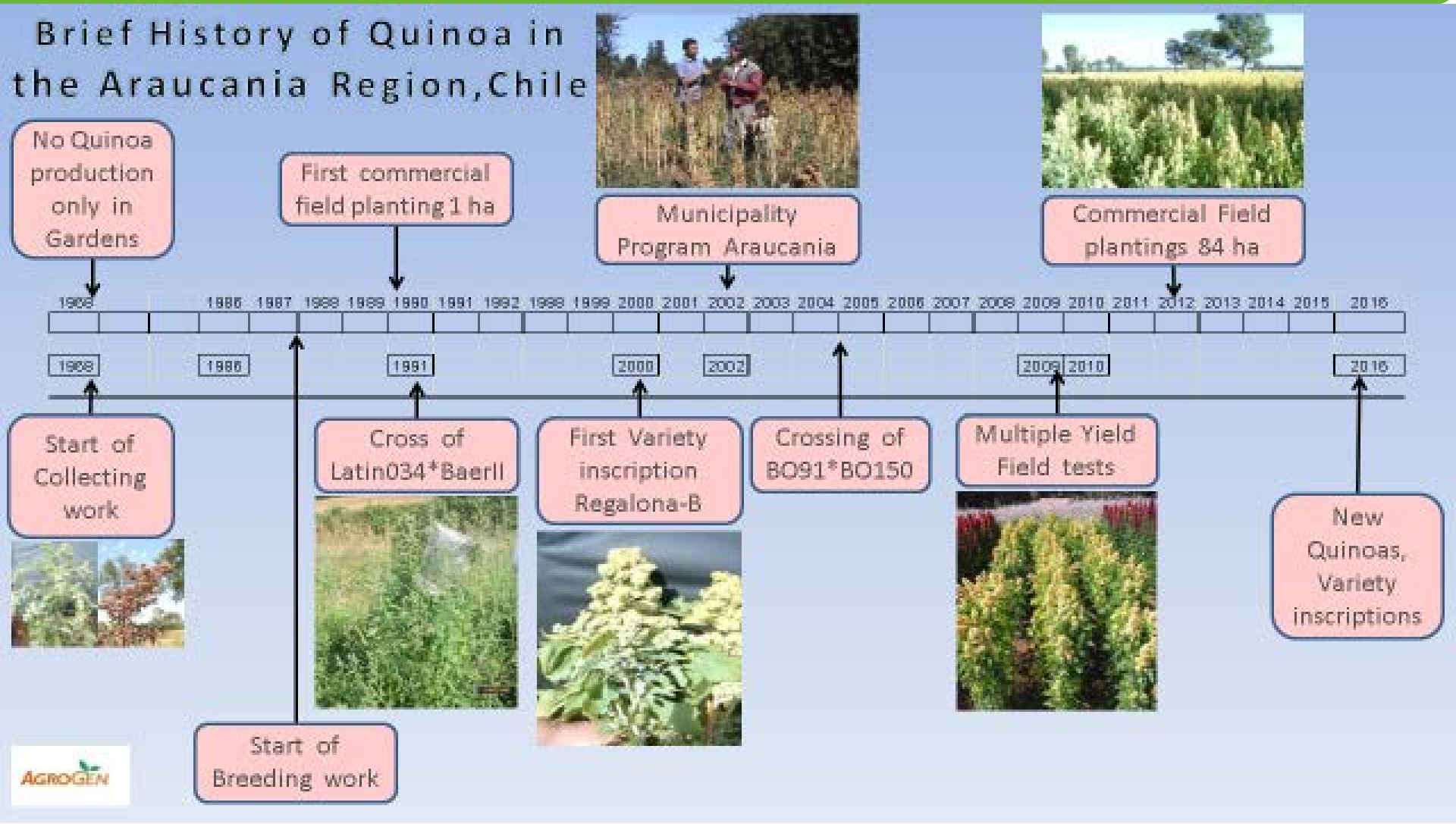
Commercial production

High radiation, cooler nights
lower humidity



Julio Rivas, INTA Ascasubi

BREEDING



Ingrid von Baer, AgroGen, Temuco, Chile. ivbaer@gmail.com

Conclusions

Main messages:

- Local germplasm was collected, conserved and characterized in Chile & Argentina
- Related to seed conservation and pre-harvest sprouting resistance, germplasm with slower seed aging and dormancy at harvest was identified and characterized
- The critical period for yield and seed number determination is identified and avenues to increase seed yield were discussed
- Contributions to knowledge about water & salinity stress
- There are breeding programs in Brazil & Chile. Late maturing varieties for tropical environments were developed by EMBRAPA (i.e. BRS Piabiru) in Brazilia from crosses between Chilean and Andean germplasm. Only one private company (AGROGEN) is involved in quinoa breeding in Chile and produced the only registered variety up to now (Regalona) in South America.
- Incipient commercial production in Argentina. Some advances in the South West pampas and Patagonia.


THANKS !!