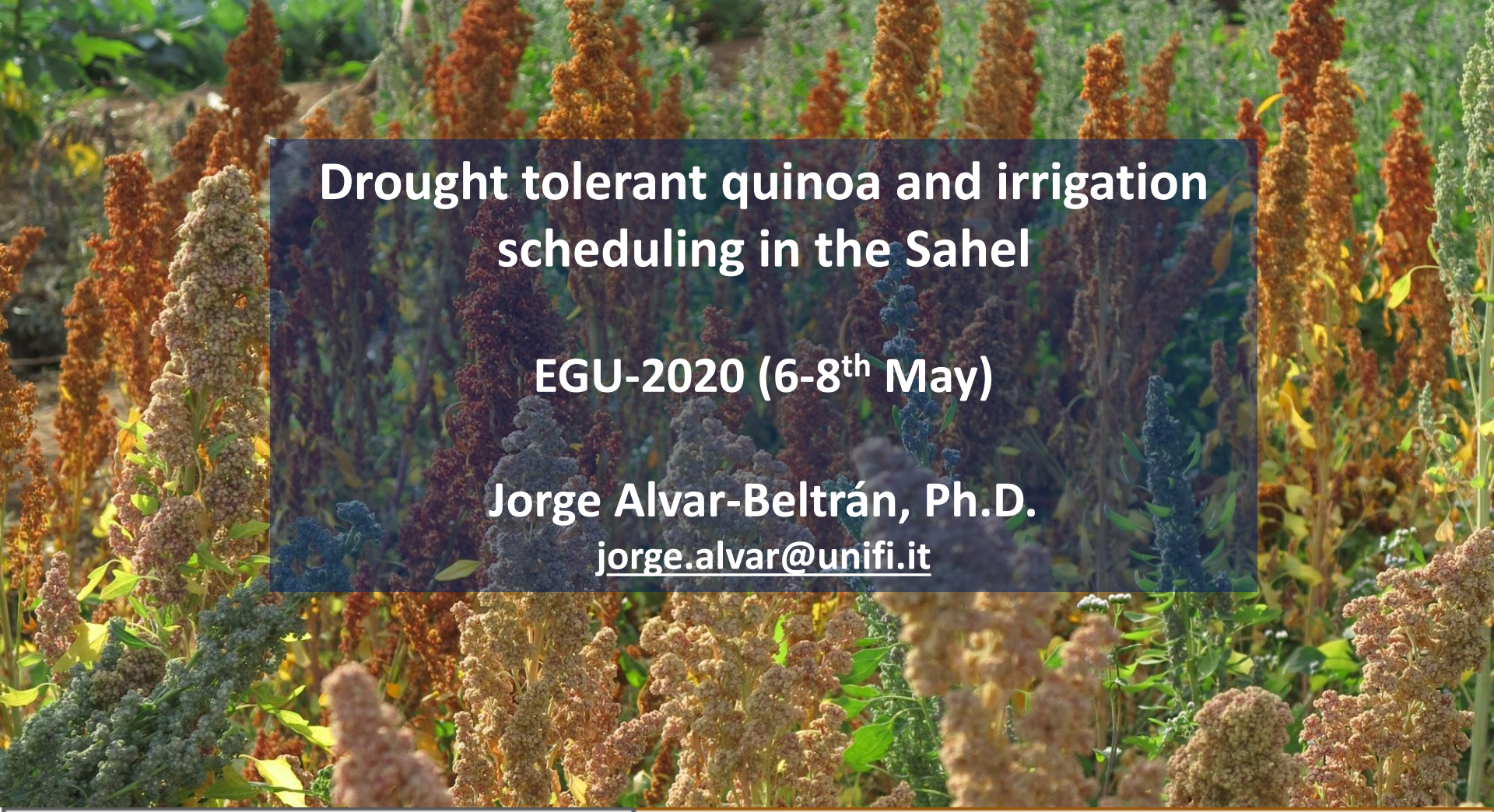


Drought tolerant quinoa and irrigation scheduling in the Sahel

EGU-2020 (6-8th May)

Jorge Alvar-Beltrán, Ph.D.

jorge.alvar@unifi.it

Prof. Simone Orlandini
Prof. Anna Dalla Marta
Prof. Jacob Sanou
Dr. Abdalla Dao
Dr. José Luís Camacho

RESEARCH COLLABORATION

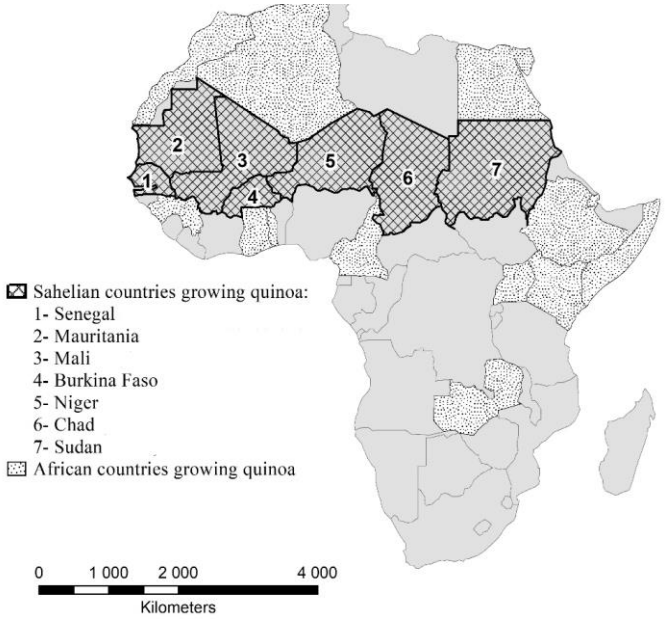
World Meteorological Organization (WMO)
Switzerland

Flemish Institute Tech. Research (VITO)
Belgium

Institut de l'Environnement et Recherches Agricoles (INERA)
Burkina Faso

Research Approach: Quinoa

- *Chenopodium quinoa* Willd. Herbaceous, C3 crop
- Traditionally grown in the Andes (7000 years)
- Thrive in a wide range of ecosystems:
  Altiplano, Inter-valleys, Salares, Coastal and Yunga
- Genetic diversity (over 16 thousand accessions)
- Abiotic stress resilience:
  a) Drought (200-400 mm)
  b) Halophyte (sea water of 600 mM NaCl)
  c) Frost (-14°C seedling & -4°C milky grains)
  d) Heat (+40°C)
  e) pH versatile & poor soils (sandy & low nutrient)
- High nutritional properties
  - Essential amino-acids & high protein content
  - Rich in Ca, Fe & Mg; vitamins A, B2 & E
  - Gluten free



Source: Vacher, 1998; Jacobsen et al., 2003; Mamedi et al., 2007; Jacobsen et al., 2010; Steduto et al., 2012; Fuentes, 2015

Tackling Problem: Quinoa Field Experiments

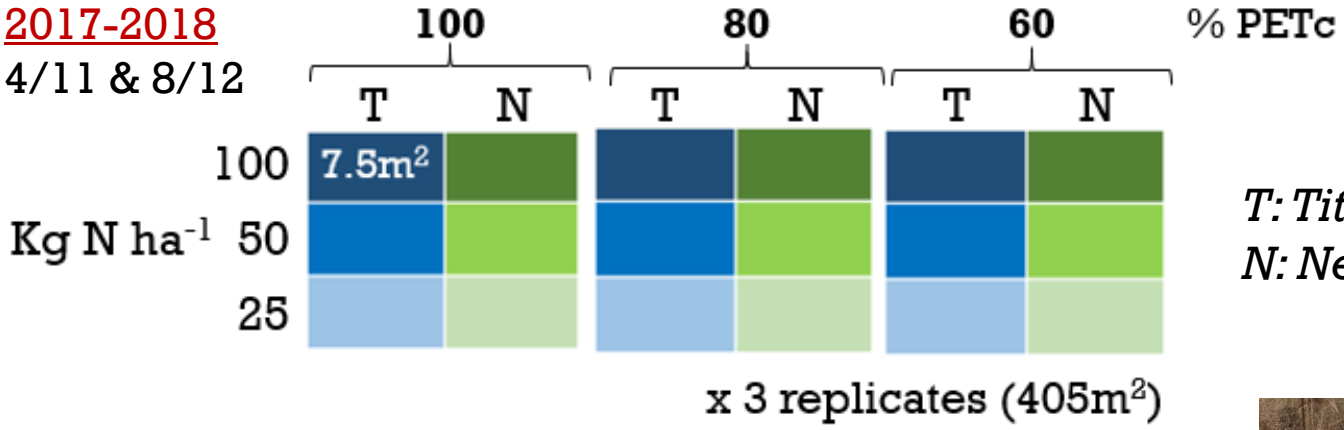
AIM

- Evaluate the adaptability of quinoa in the Sahel

EXPERIMENTAL DESIGN

2017-2018

4/11 & 8/12

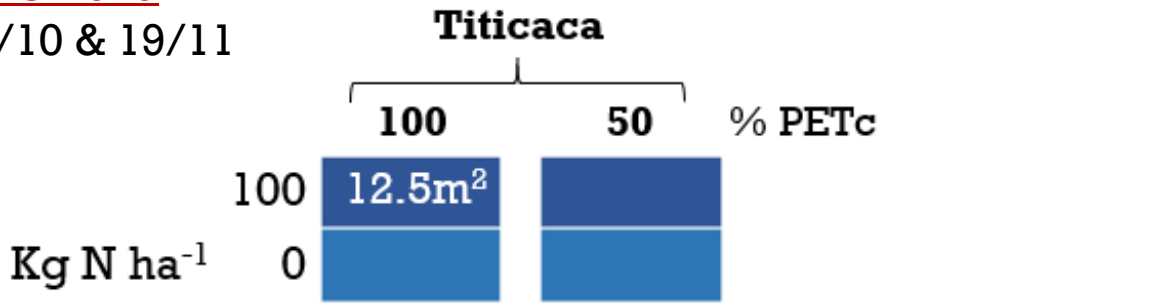


x 3 replicates (405m²)

T: Titicaca
N: Negra Collana

2018-2019

25/10 & 19/11



x 4 replicates (200m²)

Tackling Problem: Overcoming Research Barriers

IRRIGATION SCHEDULING

Evapotranspiration (ETo in mm)

$ETo = 0.0023\ (Tmean + 17.78) * Ro\ *\ (Tmax - Tmin)\ \hat{}\ 0.5$

Ro is the solar radiation (1 mm day^{-1} = 2.45 MJ m^{-2} day^{-1}).

Ro monthly adjusted during the growing season

Potential Crop ET (PETc in mm)

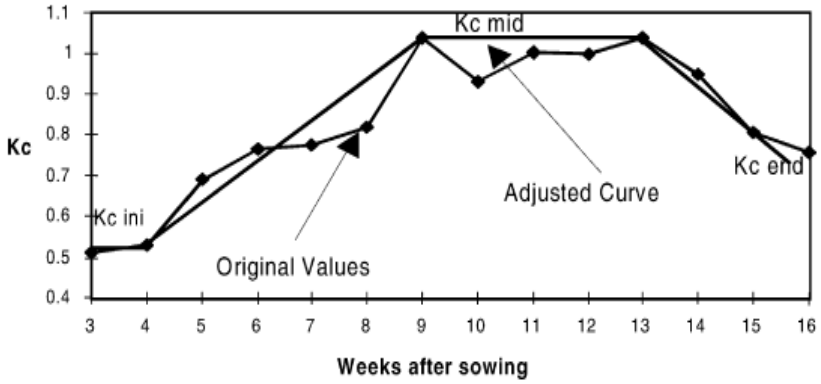
$PETc = ETo\ *\ Kc$

Kc is the crop coefficient.

Kc weekly adjusted as follows:

Kc at E, 2L, 4L, 8L, PF, F, MG, PG, PM

Kc values: 0.5, 0.6, 0.7, 0.8, 0.9, 1.0, 0.9, 0.8, 0.7



Total Irrigation (TI in l m^{-2} or mm)

$$TI = \left(\left(\frac{m^3}{1000}\right) \div m^2\right) - 70$$

70 liters of water to attain drip-irrigation working pressure

Source: Hargreaves & Samani, 1985; Allen et al. 1998; García et al. 2003

Tackling Problem: Quinoa Field Experiments

FIELD & LAB MEASUREMENTS

Irrigation
- Amount, frequency & timing

Agro-meteorology
- Tmax, Tmin, T mean, precipitation, RH & PETc
- Soil temperature
- Solar radiation & photoperiodicity

Plant phenology and physiology
- Time E, 2L, 4L, 8L, PF, F, LS, MG, PG, PM
- Plant height, panicle length & width, root architecture, n° of branches & stem diameter
- Kernel weight, biomass/yield production & canopy cover

Soil characteristics
- pH, soil texture, org. matter, N, C, P, K content & bulk density

Tackling Problem: Quinoa Field Experiments

RESULTS

TITICACA VS. NEGRA COLLANA

Crop variety	Titicaca	Negra Collana
Seed yield (kg ha^{-1})	686 **a**	102 **b**
Biomass (kg ha^{-1})	1686 **a**	1725 **a**

⚠ *Average of all treatments (irrigation & N-fertilization) & sowing dates (4-Nov and 8-Dec). Experiment 2017-2018*

TITICACA (Two year experiment 4-sowing dates)

- Main effect N-fertilization ($p>0.05$).
- Main effect Irrigation ($p<0.05$). 100 & 80 vs. 60 & 50 PETc
- Sowing dates ($p<0.05$). 25-Oct vs. 8-Dec

Sowing date	25-Oct	4-Nov	19-Nov	8-Dec
Seed yield (kg ha^{-1})	1128**a**	898**ab**	659**ab**	540**b**

⚠ *Titicaca: best irrigation schedules (FI & PD) & all N-fertilization levels (100, 50, 25 & 0 kg N ha^{-1}).*

Publications

Effect of drought and nitrogen fertilisation on quinoa (*Chenopodium quinoa* Willd.) under field conditions in Burkina Faso

Italian Journal of Agrometeorology
Rivista Italiana di Agrometeorologia

Effetto della siccità e della fertilizzazione azotata su quinoa (*Chenopodium quinoa* Willd.) in Burkina Faso

Jorge Alvar-Beltrán[1,*], Coulibaly Saturnin[2], Abdalla Dao[2], Anna Dalla Marta[1], Jacob Sanou[2], Simone Orlandini[1]

agronomy

MDPI

Article

Effect of Drought, Nitrogen Fertilization, Temperature and Photoperiodicity on Quinoa Plant Growth and Development in the Sahel

Jorge Alvar-Beltrán [1,*], Abdalla Dao [2], Anna Dalla Marta [1], Coulibaly Saturnin [2], Paolo Casini [1], Jacob Sanou [2] and Simone Orlandini [1]