TRENDS IN ROOT ARCHITECTURE FOR HISTORICAL AND CONTEMPORARY WHEAT CULTIVARS OF URUGUAY

Anika Miller-Cooper*[1] Marina Castro*[2], Cecile Richard[1,] Martin Quincke[2], Lee Hickey[1] |

1. The University of Queensland, Queensland Alliance for Agriculture and Food Innovation, St Lucia, QLD 4072, Australia 2. Instituto Nacional de Investigación Agropecuaria, La Estanzuela, Colonia, CP 70006, Uruguay *anikamill@yahoo.com *mcastro@inia.org.uy

Why target root system architecture?

- Root system architecture plays a key role in nutrient and water uptake efficiency, but also for tolerance to abiotic stress [1]
- Studies suggest narrow angle root growth is desirable for wheat in deep soils with high water holding capacity and low in-season rainfall [1]
- High number of seminal roots can also improve access to water at depth [1]
- Seminal root angle (SRA) in seedlings is associated with root system architecture in adult plants.

Aim

- **Investigate whether selection and breeding in changing environments are reflected in wheat root system architecture** in a panel of historic an contemporary wheat cultivars grown in Uruguay
- Insights for **desirable root systems** in Uruguayan environments

Materials and Methods

- **A collection of historic and contemporary spring wheat cultivars grown in Uruguay from 1918-2017**
- Cultivars originated from Brazil, Uruguay, Argentina, France, CIMMYT and Australia (2 checks)
- The panel was assessed for seminal root angle (SRA) and number (SRN) using the **"clear pot" method** [2] **(Figure 1)**
- Best linear unbiased estimators (BLUEs) calculated for SRA and SRN using R statistical package
- Data analysis using historical yield, physical and phenological data

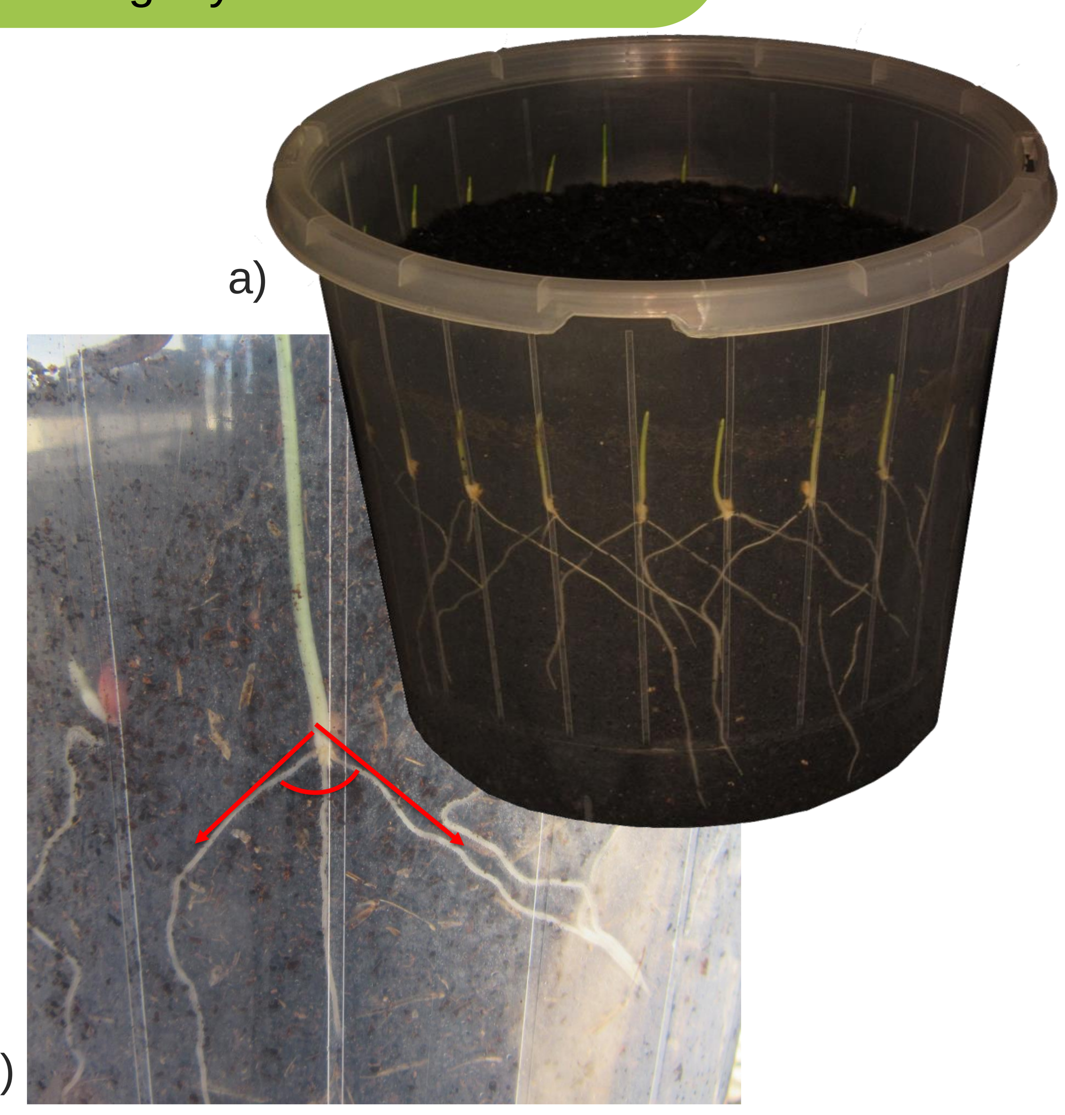

Figure 1. a) "Clear pot" method [2]
b) imaged roots 5 days after sowing

Figure 2. Imaging at INIA Uruguay glasshouse to phenotype SRA using the "clear pot" method [2]

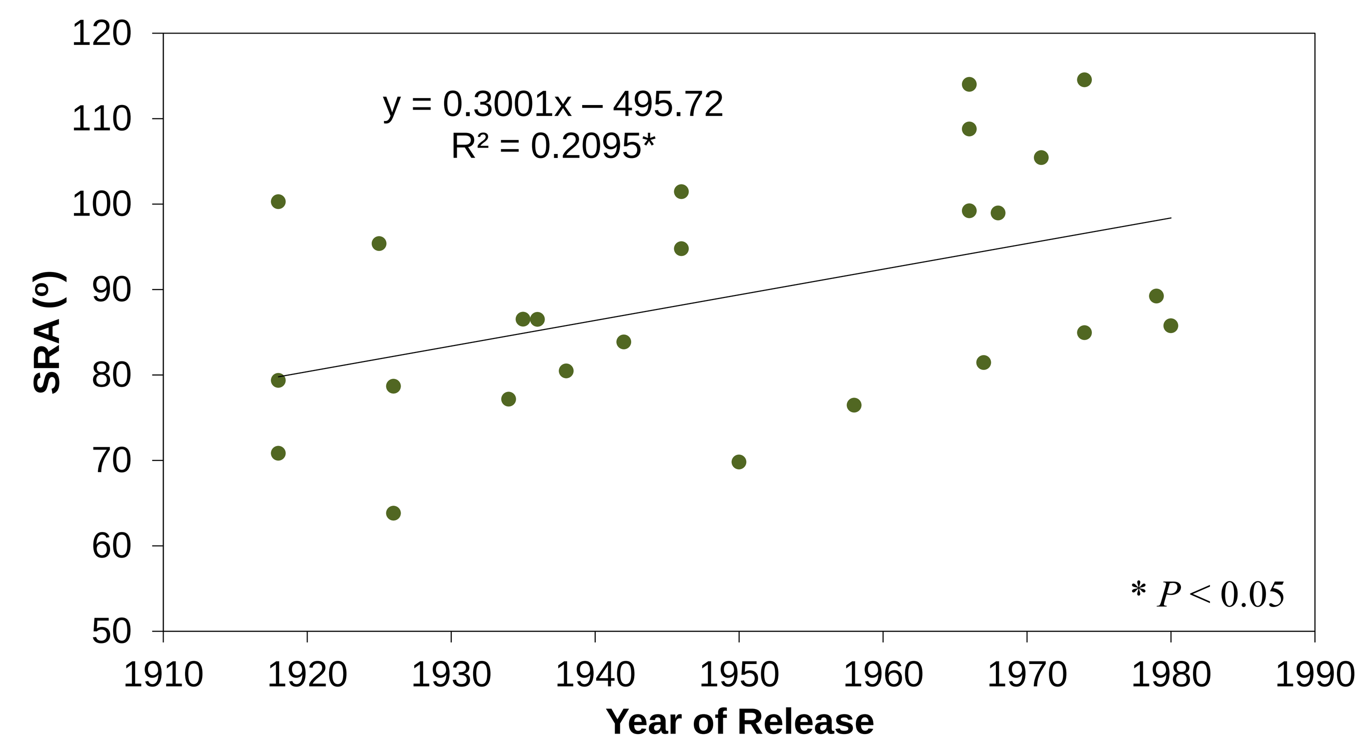

Figure 3. Increasing SRA (wide angle) trend from 1918 to 1980.

Results & Discussion

- SRA BLUEs ranged from 64˚ ±11 (Larrañaga, Uruguay, 1926) to 116˚ ±11 (Klein Tauro, Argentina, 2008). SRN BLUEs ranged from 2 ±0.5 (INIA Carpintero, Uruguay, 2007) to 4 ±0.3 (Estanzuela Tarariras, Uruguay, 1974)
- Increasing SRA from 1918 to 1980- Breeding using regional germplasm, in an high rainfall environment (700 mm in the wheat growing cycle), resulted **in indirect selection for cultivars with wider SRA (Figure 3)**
- From **1980 dramatic increase in SRA diversity**- coinciding with introduction of CIMMYT spring germplasm, selected first in high yield potential environments and afterwards in drought environments using raised beds **(Figure 4)**
- Field management practices changed in 2002 to no-till (improving soil structure and water infiltration) ~ high proportion of contemporary cultivars displaying narrow SRA-this trait may be advantageous in these conditions
- Changes to above ground traits that influence water demand, like tillering & flowering time, could lead to **different pathways for increased yield**

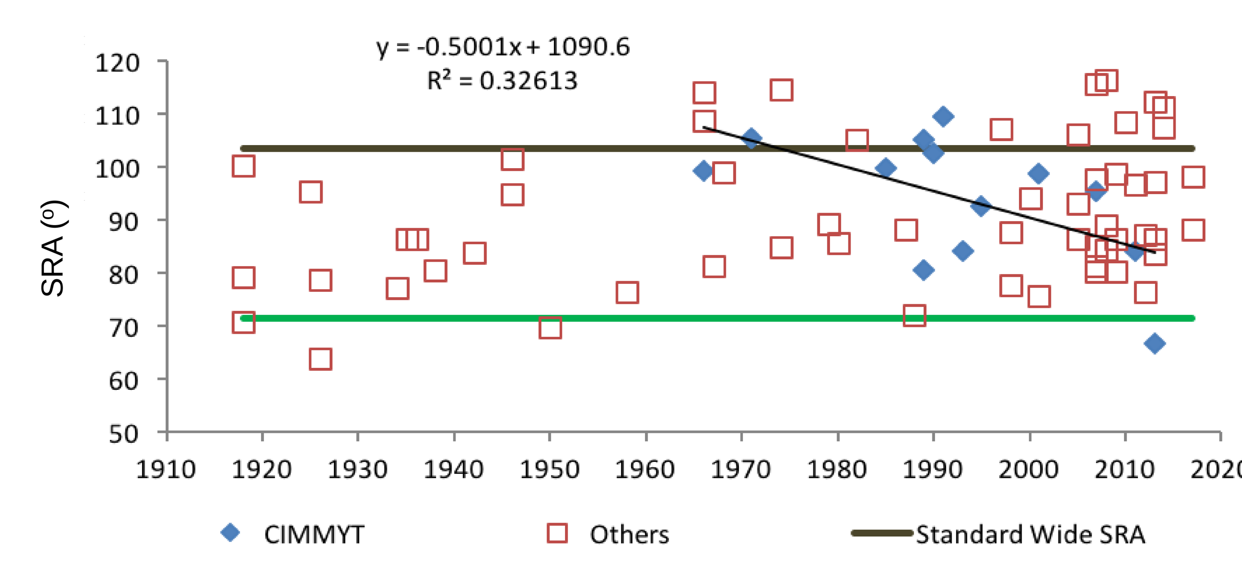

Figure 4. SRA against year of release. CIMMYT cultivars narrowing SRA, local germplasm (Others) increased SRA diversity

Implications

- Greater understanding of trait interactions on a whole plant system level
- Desirable root trait combinations can be harnessed by breeders and incorporated into elite cultivars to improve **sustainable wheat production** adapted for selected **environments**

References

1. Christopher, J. et al. (2013), Theoretical and Applied Genetics, 126: 1563-1574.
2. Richard, C. A., et al. (2015). Plant methods 11: 13-13.

THE UNIVERSITY OF QUEENSLAND AUSTRALIA | QAAFI Queensland Alliance for Agriculture & Food Innovation | HICKEY LAB www.hickeylab.com | INIA Instituto Nacional de Investigación Agropecuaria URUGUAY | THE CRAWFORD FUND For a Food Secure World | Working together with the Queensland Government | Queensland Government