Classification of Pulses Diversity for the Provision of Ecosystems Services: a focus on Nitrogen Fixation, Weed Suppression, and Production Under Dry Conditions.

J. Pitchers-Guiguitant¹, H. Marrou¹, M. E. Ghanem², J. Wery³

1. UMR System, Montpellier SupAgro, Montpellier, France
2. iTK, CAP ALPHA - Avenue de l'Europe - 34830 Clapiers
3. International Center for Agricultural Research in the Dry Areas (ICARDA), Cairo, Egypt
An under-exploited diversity

Many benefits: affordable protein, nitrogen saving (Singh et al., 2003)

Large specific diversity: 80 species recorded as pulses (Tiwari, Gowen and McKenna, 2011)

→ diversified biological functioning’s (Doyle, 2003)

→ Potential to adapt cropping systems to water and heat stress

However, Legumes are poorly represented throughout the world

80 species of pulses consumed worldwide

Only 3 species represent 2/3 of the production
Trait-base approach

**Aim**: a better characterization of pulses genetic diversity and its role in the provision of ecosystem services

- Yield production and stability under dry conditions
- Nitrogen fixation
- Competitiveness toward weeds.
3 step of investigations

1) documentation of 44 species over 17 Traits:
   - Phenology (life cycle, days to flowering)
   - Seeds traits (size, weight, oil and protein content)
   - Leaf traits (nb of leaflets, length, width, amount of nitrogen, SLA)
   - Root traits (root depth)
   - Development (habit, height, HI, root to shoot ratio, germination type)

2) Identification of 6 functions related to the targeted services

\[
\text{Food services}_{\text{drought}} = \frac{Yield}{Tr} \times \text{water}_{\text{available}} = \text{WUE} \times \text{water}
\]

\[
\text{Nitrogen supply} = \text{BNF} = \text{biomasse} \times \%\text{Nd f a} \times [N]_{\text{total}}
\]

\[
\text{Weed interference} = \Delta \text{Yield} = f \left( \frac{\text{Flowering} - \text{Germination}}{LAI_{\text{max}}} \right)
\]
3 step of investigations

3) Prediction of these 6 functions from plant trait values using CART

Example of CART regression.
(personnall sources)
Food production under drought

In general Better Yield = lower WUE

To improve yield under drought plant should have:

• Larger seed
• Hypogeal germination
• Larger SLA
• Larger Leaf
• Later flowering

Better seed inbibition, early vigour

Water conservation, Transpiration rate

Photosynthesis

Correlation between function of WUE and Potential Yield (personal sources)

Representation of traits value that could maximize WUE and/or Grain Yield (personnal sources)
Nitrogen Supply

Biomass low for high Percentage of Nitrogen fixed
To improve yield under drought plant should have:

- Taller plant
- Erect habit
- Hypogeal germination
- Larger SLA
- Larger Leaf

Maximise biomass and photosynthesis
Early onset of nodulation
Photosynthesis

Correlation between function of Biomasse and %Ndfa (personal sources)

Representation of traits value that could maximize Biomasse and/or %Ndfa (personal sources)
Competitiveness towards weeds

Large diversity of weed competitiveness

To improve yield under drought plant should have:

- smaller seed
- Heavy seed
- Hypogeal germination
- Larger SLA
- Climbing/prostate habit

Better seed inhibition, early vigour

Earlier establishment

Light interception

Correlation between function of Yield loss and LAI maximum (personal sources)

Representation of traits value that could maximize Yield loss and/or LAI maximum (personal sources)
Conclusions

Early seedling development (Germination type, Seed size, PMG) (Fayaud et al. 2014; Aronson J. 1991)

Early vigour persist as plants reach maturity (Burris et al., 1973; Clark and Peck, 1968; Sangakkara, 1989)

And play a critical role in the establishment of the future competition for resources toward weeds (Gosse et al. 1986; Fayaud et al. 2014; Tamet V. et al. 1996;)

Leaf morphology and plant architecture as plant reach maturity (Leaf size, SLA, Plante Height, Habit)

To improve efficacy of resource uses
To improve accumulation of Nitrogen an Dry matter
Thank You

Get in Touch
Pitchers Julie

2 place pierre Viala 34000 Montpellier, France
pitchers@iamm.fr
+33652411304