Phenotypic traits expressed for white clover cold tolerant genotypes collected in the Patagonia region of South America

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INIA
Ministerio de Agricultura

Gobierno de Chile

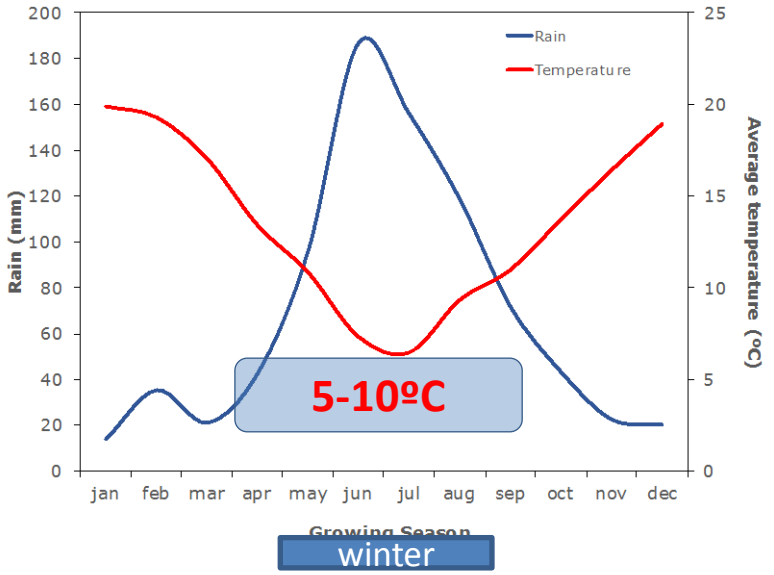





Grazing livestock system in Chile

Perennial ryegrass/white clover

Mediterranean environments



- Cold and rainy winter
- Hot and dry summer

Mixed sward growth rate in Mediterranean environments

The cold season affects the WC contribution to the mixture.

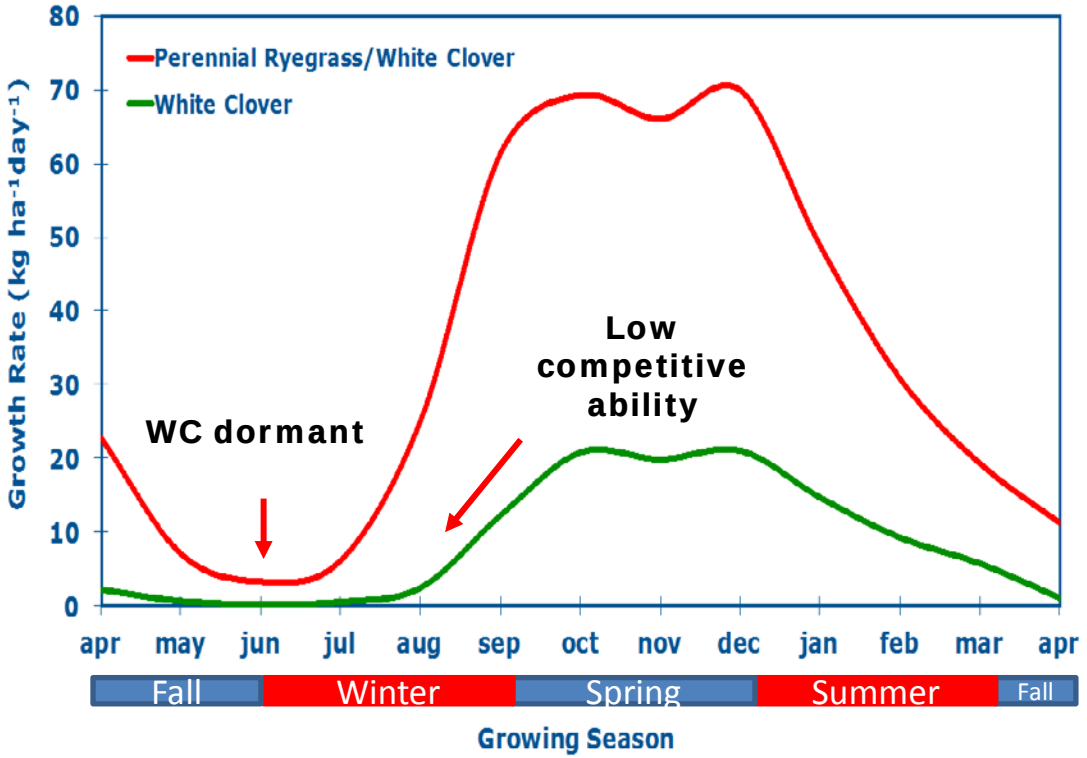
- WC is dormant and PR has a low growth rate.
- WC > PR thermal requirements.

Improving WC cold tolerance:

-annual DM production.

-extend the grazing period.

-conserved forage.



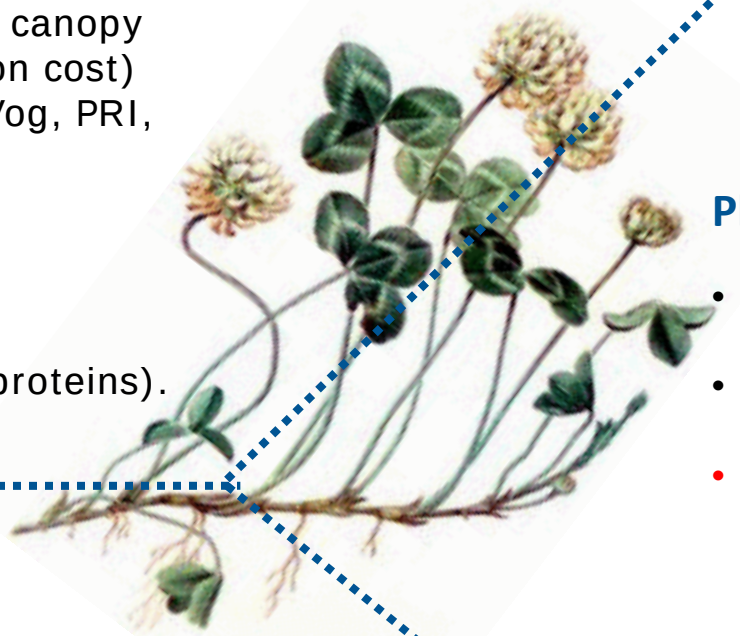
Cold tolerance conceptual model

Idiotype for Mediterranean environments

Early vigor during Spring

(growth capacity low T)

- High Photosynthetically active canopy during winter (lower respiration cost)
  - Spectral indices (NDVI, Vog, PRI, among others).
  - High growth rate
  - High petiole length
  - High LA
- High Nº stolon growing points
- High Nitrogen reserves (VPS-proteins).



Plant Survival + Early vigor

- Low growth rate during cold season.
- High competitive ability with Perennial Ryegrass
- **High DM production during spring**

Plant Survival during Winter

(storage capacity)

- Cold acclimation traits (5-10ºC)
  - Low GR during fall
  - High stolon DM partitioning
- Stolon CHO metabolism
  - High CHO accumulation
  - Slow CHO degradation
- Stolon thermo stability
- Stolon osmotic potential

White clover association mapping (WCAM) population

1800 genotypes

- 28 Naturalized Populations Patagonia Area of South America
- 2 commercial cultivars

Cold Tolerance Filter

- Indoor methodology
- 0, -2, -4, -6, -8ºC
- LT50 selection criteria

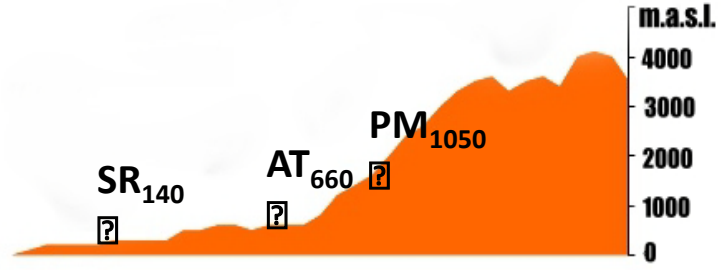
WCAM population (192)

- 96 cold sensitive (3 pop)
- 96 cold tolerant (3 pop)

Acuña et al., 2014

Multi-location trial

- 3 Locations with winter cold gradient associated with the altitude.
- Same longitude (36ºS)
- WCAM pop clonally propagated
- Spaced plant (1x1 m)
- Alpha Lattice experimental design (2 rep, 24 IB(rep)).



Plant phenotyping

During three growing season:

- DM production
- Canopy reflectance and temperature
- Spectral images aerial with a UAV-drone
- Leaf traits
  - Petiole length
  - Leaf area
  - SLA (cm^2/g)
- Stolon traits during the growing period (2 stol/plan)
  - Length
  - Diameter
  - Internode length
  - Stolon elongation rate
- Stolon traits during winter period
  - stolon-WSC were determined in three times: early, middle and late of winter.
  - Stolon osmotic potential (late winter)
  - Stolon membrane thermo-stability (late winter)

  Core sample (8 cm diam)
  - Stolon DW
  - Stolon Length
  - Stolon diameter

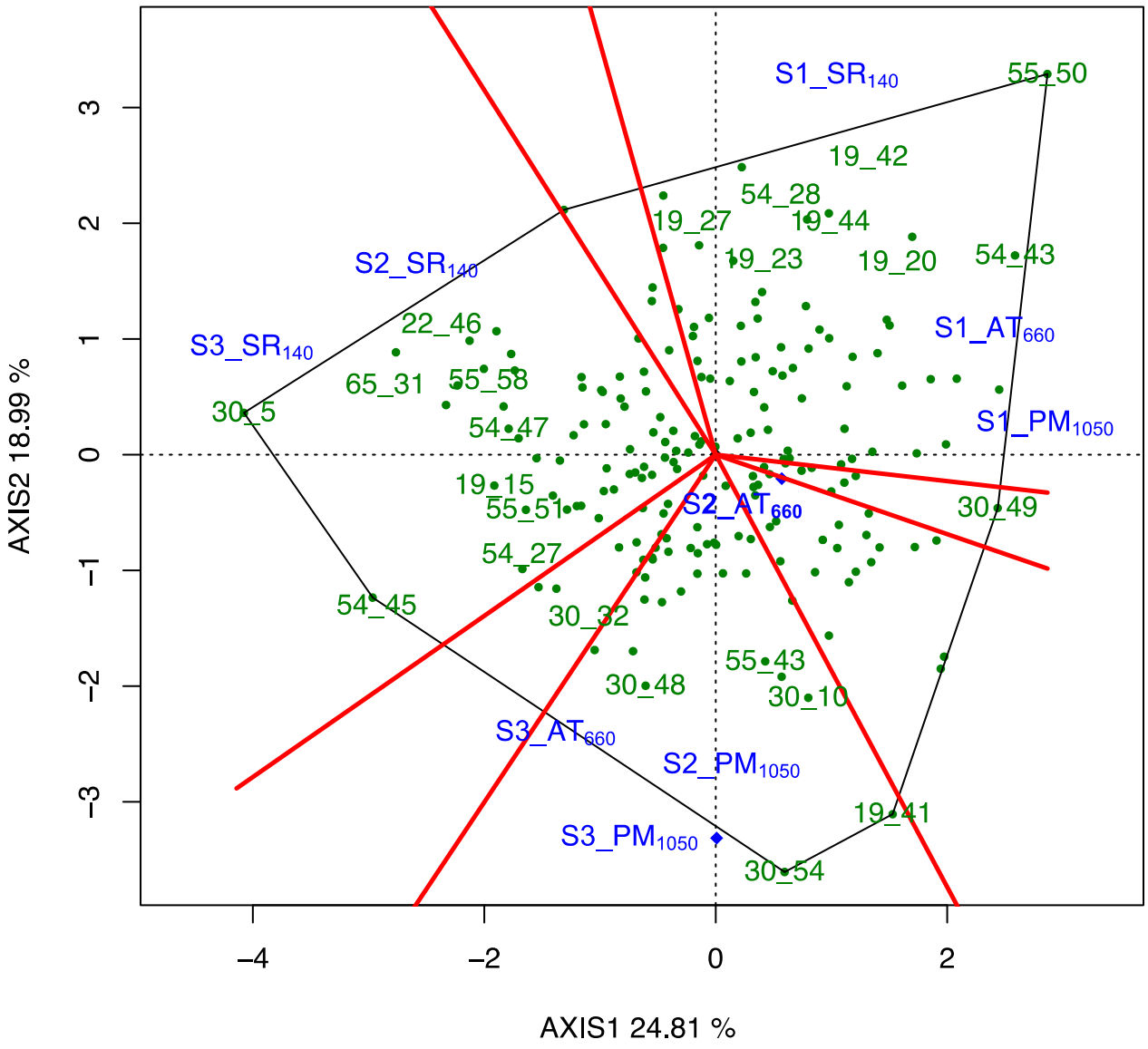
DM production components of variance and H^2

$$Y_{ijklm} = \mu + l_j + a_k + r_l + IB_m + g_i + g{\times}l_{ij} + g{\times}a_{ik} + g{\times}l{\times}a_{ijk} + \varepsilon_{ijklm}$$

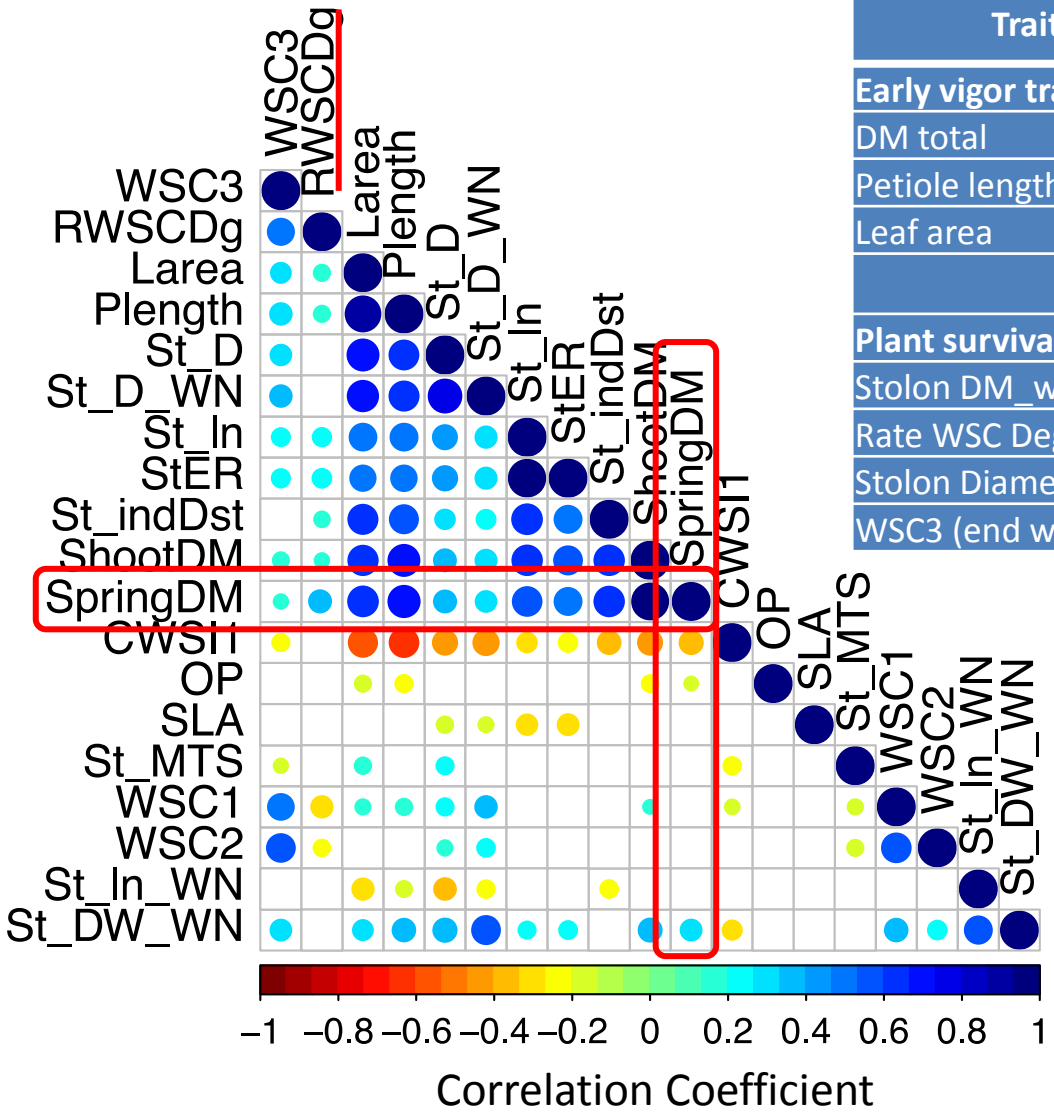
DM production	σ^2_g	$\sigma^2_{g\times l}$	σ^2_ε	H^2
Season 1 (2013/14)	397.8±94.4 ***	292.4±99.7 ns	1169.2±86.8	0.49±0.08
Season 2 (2014/15)	3856.9±524.6 ***	476.5±308.1 ns	5968.5±358.9	0.73±0.04
Season 3 (2015/16)	471.6±97.1 ***	0.0±0.0 ns	2442.9±119.6	0.53±0.06

DM production	σ^2_g	$\sigma^2_{g\times l}$	$\sigma^2_{g\times y}$	$\sigma^2_{g\times y\times l}$	σ^2_ε	H^2
All seasons	1308±216.3 ***	292.2±139.8 ns	782.8±166.8 ***	1485.8±193.2 ***	5052.1±178.2	0.55±0.05

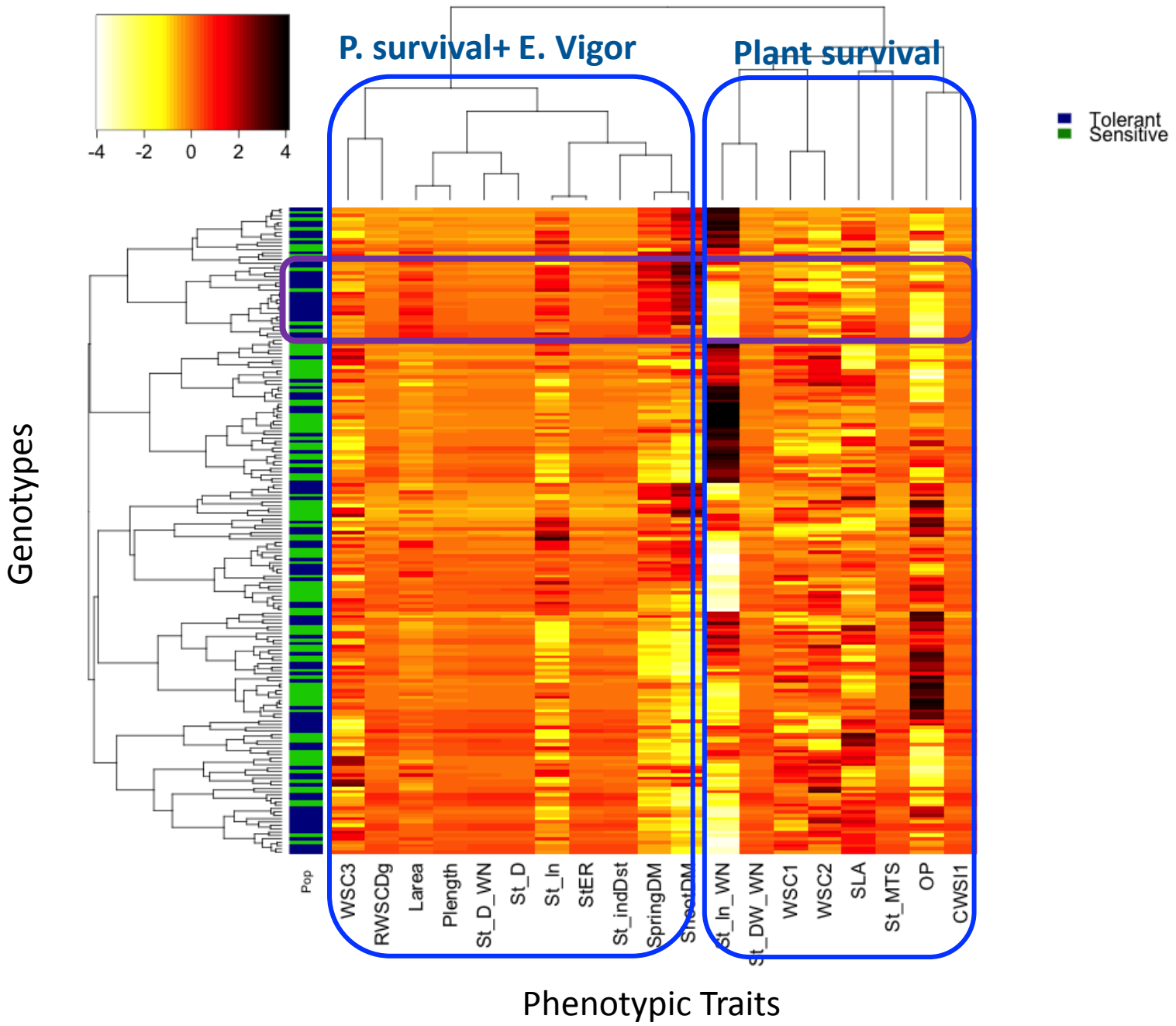
DM production GGE biplot

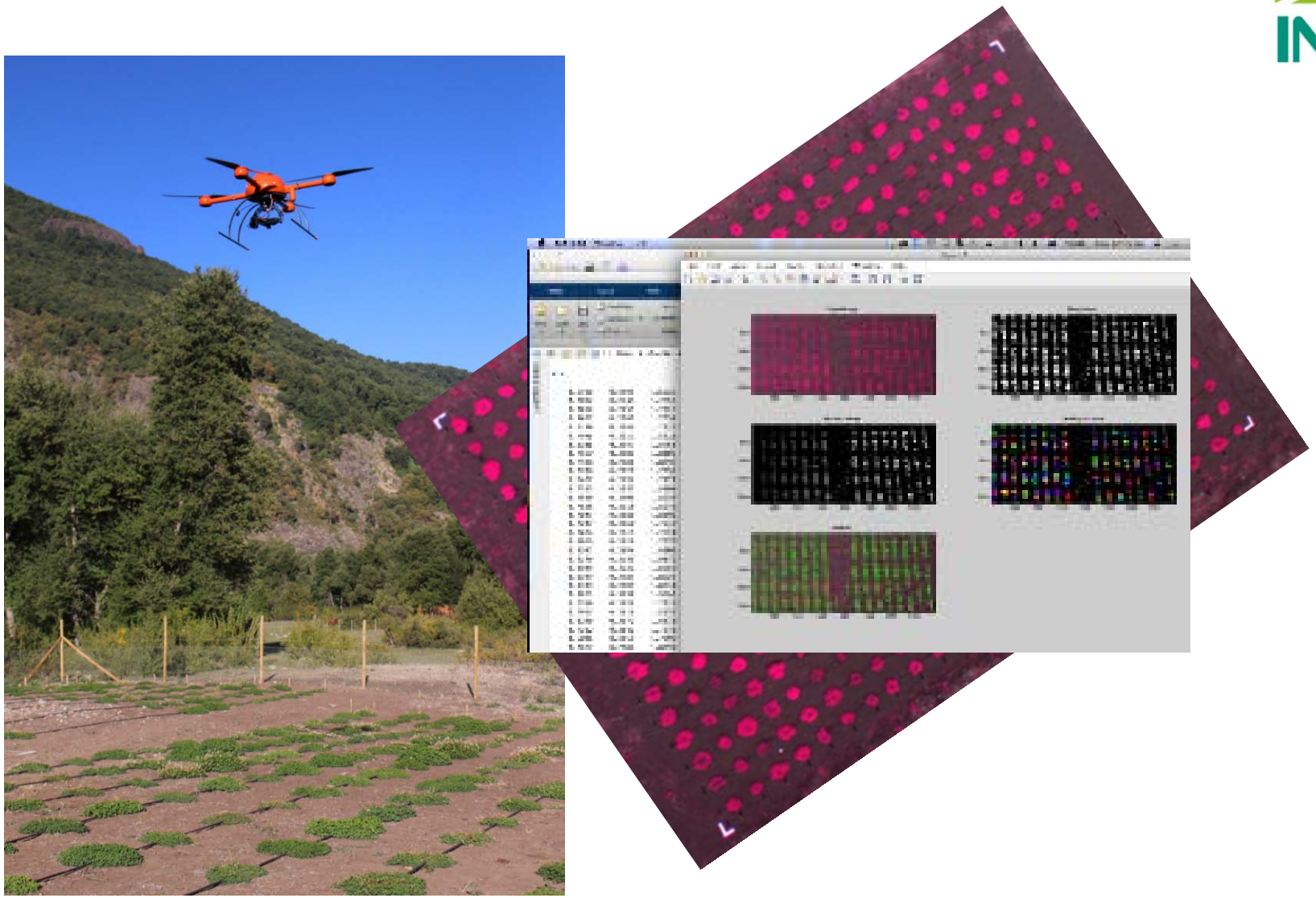


Phenotypic traits and early vigor

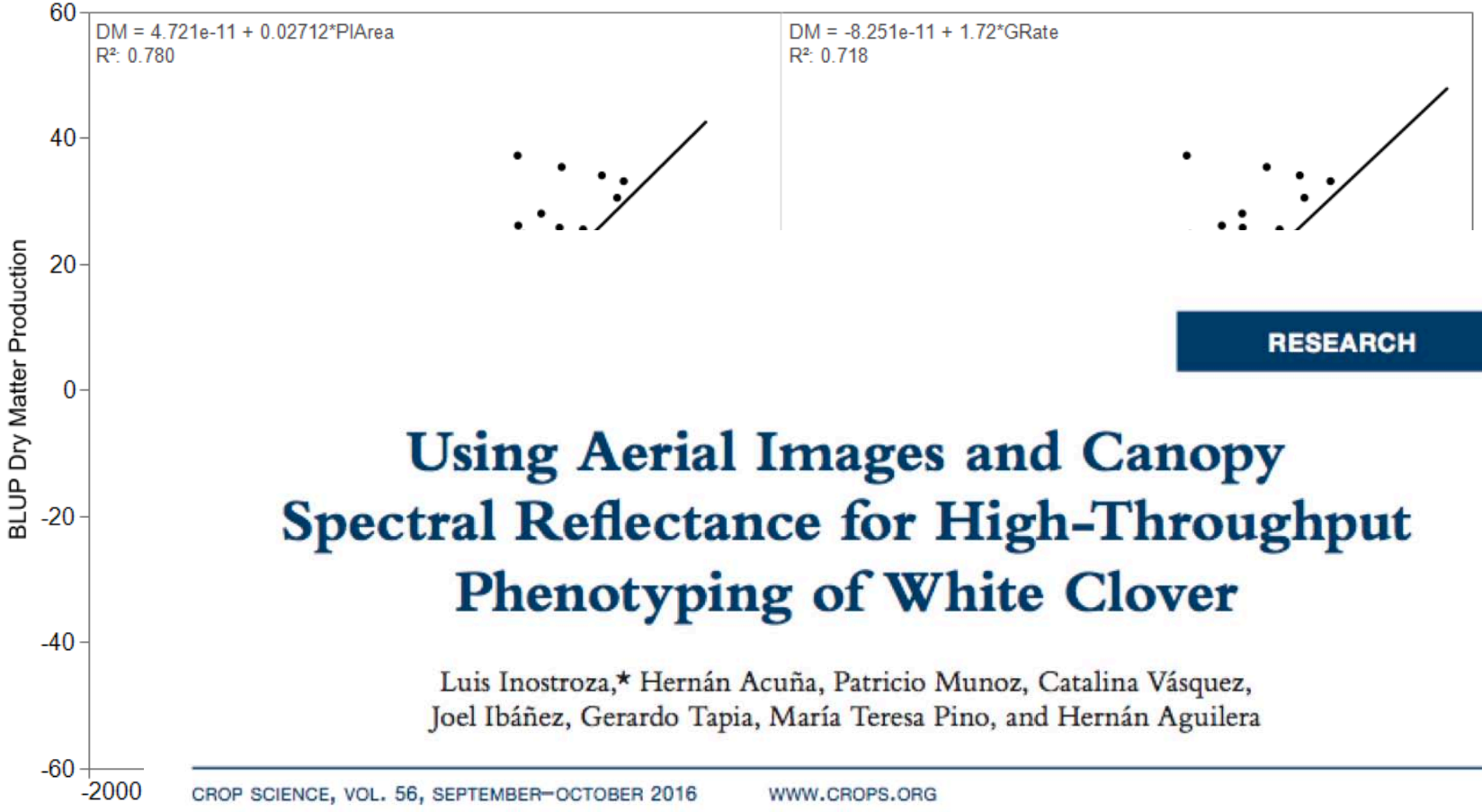


Traits	r_g Spring DM	H^2
Early vigor traits		
DM total	0.94± 0.02	0.55±0.05
Petiole length	0.77± 0.04	0.75±0.03
Leaf area	0.71± 0.05	0.82±0.02
Plant survival traits		
Stolon DM_winter	0.70± 0.29	0.36±0.08
Rate WSC Degradation	0.64± 0.22	0.19±0.08
Stolon Diameter winter	0.47± 0.10	0.78±0.03
WSC3 (end winter)	0.28±0.11	0.52±0.06


P. survival+ E. Vigor
Plant survival
-4
-2
0
2
4
Tolerant
Sensitive
Genotypes
Pop
WSC3
RWSCDg
Larea
Plength
St_D_WN
St_D
St_In
StER
St_indDst
SpringDM
ShootDM
St_In_WN
St_DW_WN
WSC1
WSC2
SLA
St_MTS
OP
CWSI1
Phenotypic Traits



Relationship between DM production and some image-aerial estimated traits



RESEARCH

Using Aerial Images and Canopy Spectral Reflectance for High-Throughput Phenotyping of White Clover

Luis Inostroza,* Hernán Acuña, Patricio Munoz, Catalina Vásquez, Joel Ibáñez, Gerardo Tapia, María Teresa Pino, and Hernán Aguilera

Conclusions

- Broad phenotypic variation was observed for cold tolerance and early vigor in the WCAM populations.
- Leaf traits were related to early vigor and stolon traits to storage capacity and plant survival.
- Currently we are identifying the genomic regions (QTLs) controlling the expression of this phenotypic traits in white clover.

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