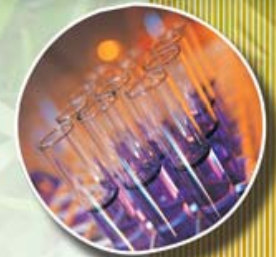




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Red Clover Varieties with Nitrogen Fixing Advantage during the Early Stages of Seedling Development

Yousef A. Papadopoulos

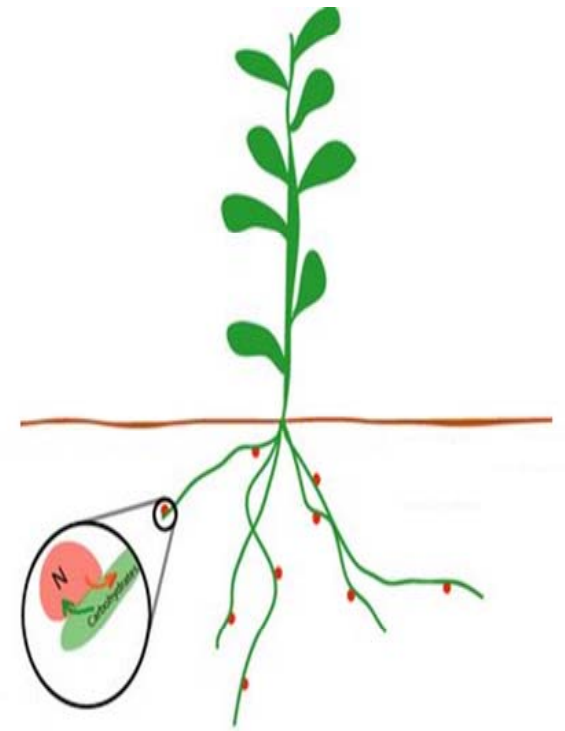
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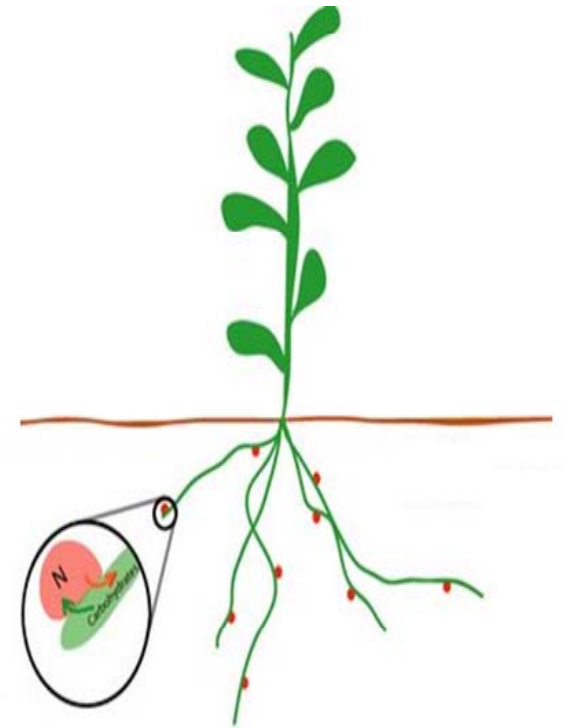
Objective

- To assess the genotypic variability among red clover varieties for nodulation potential and nitrogen fixation during the early stages of seedling development.
- **By measuring nodulation/plant growth traits, total plant N content and net N exudation at three periods during the first 9 weeks following germination.**



Starter nitrogen fertilizer during the establishment of legume forage stands

- Nitrogen is a growth-limiting nutrient at the early stages of forage stand establishment.
- Current recommendations indicate that forage legume plants at the establishment stage need access to nitrogen through the addition of chemical fertilizers.
- However:
 - increasing price of inorganic nitrogen
 - nitrogen fertilizers have been linked to a number of environmental issues
- **Can we achieve good legume establishment in the absence of nitrogen fertilizer?**



Experiment 1

Characterization of diverse red clover cultivars for nodulation, growth and nitrogen uptake under different levels of N fertilization

Materials and Methods

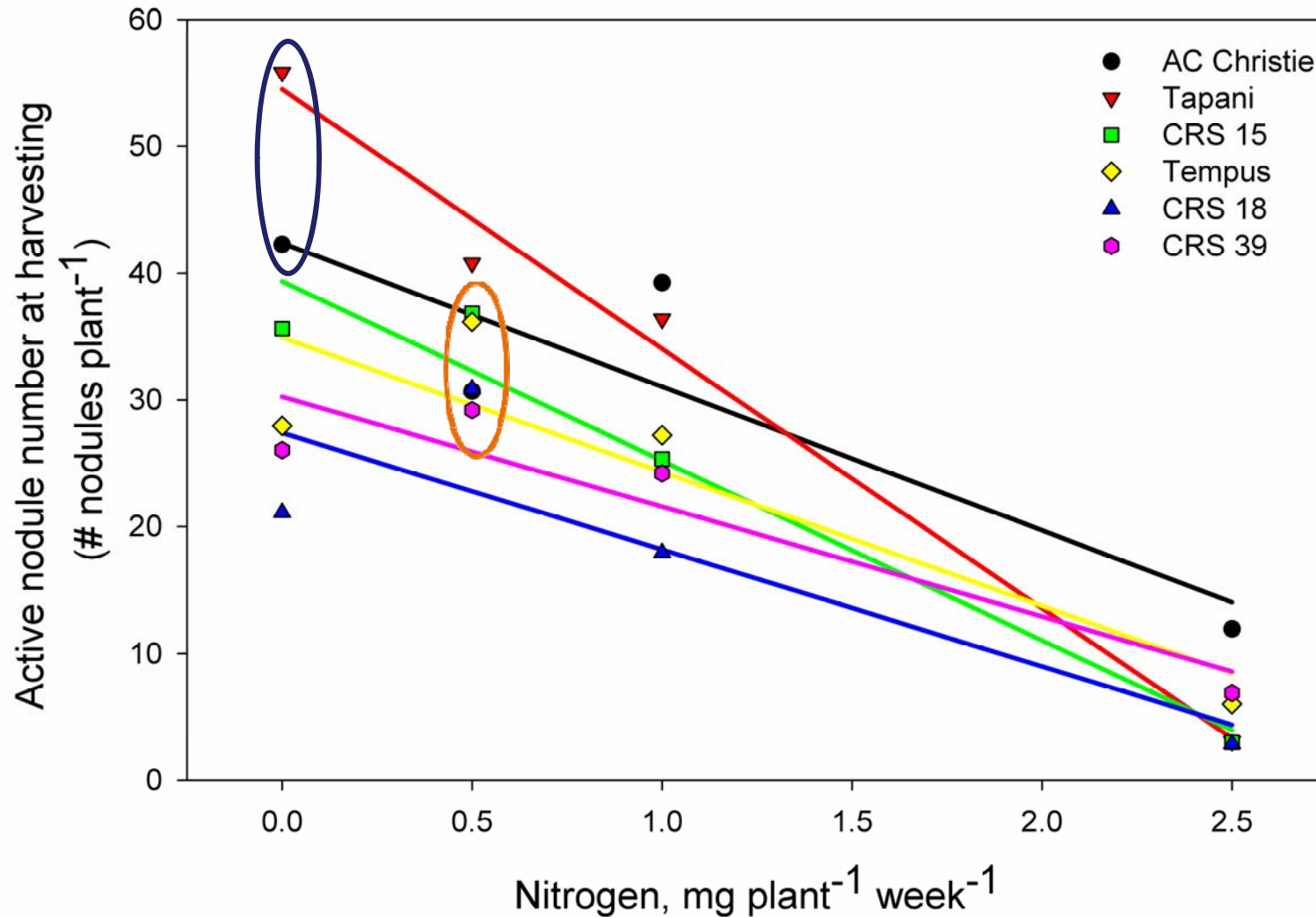
- Inoculation - *Rhizobium leguminosarum* biovar *trifolii*
- N free Hoagland's nutrient solution
- Nitrogen concentrations: 0, 0.5, 1.0, and 2.5 ($\text{mg plant}^{-1} \text{ week}^{-1}$)
- Plant sampling at 8 weeks

Data collection

- Active nodule number
- Leaf area, shoot and root dry weight
- Shoot and root total N%



Active Nodule Number



Nitrogen x Cv; $p = 0.083$
lin N. Dip vs Tetra; $p = 0.019$

Nodulation in response to N application is cultivar dependent

Experiment 2

Nodulation, plant growth, N fixation, and N exudation of diverse red clover cultivars during the early stages of seedling development

Materials and Methods

- Growth chamber trial, Six red clover cultivars
- Inoculation - *Rhizobium leguminosarum* bv *trifolii*
- N-free Hoagland's nutrient solution
- Root exudate collection at 4, 6 and 8 weeks
- Plant sampling - 8 weeks

Data collection

- Active nodule number (4, 6 and 8 wk), Average nodule DW
- Total leaf area and root morphological characters
- Shoot and root dry weight and total N content
- Root exudates: NO_3^- , NH_4^+ , total dissolved nitrogen (TDN)

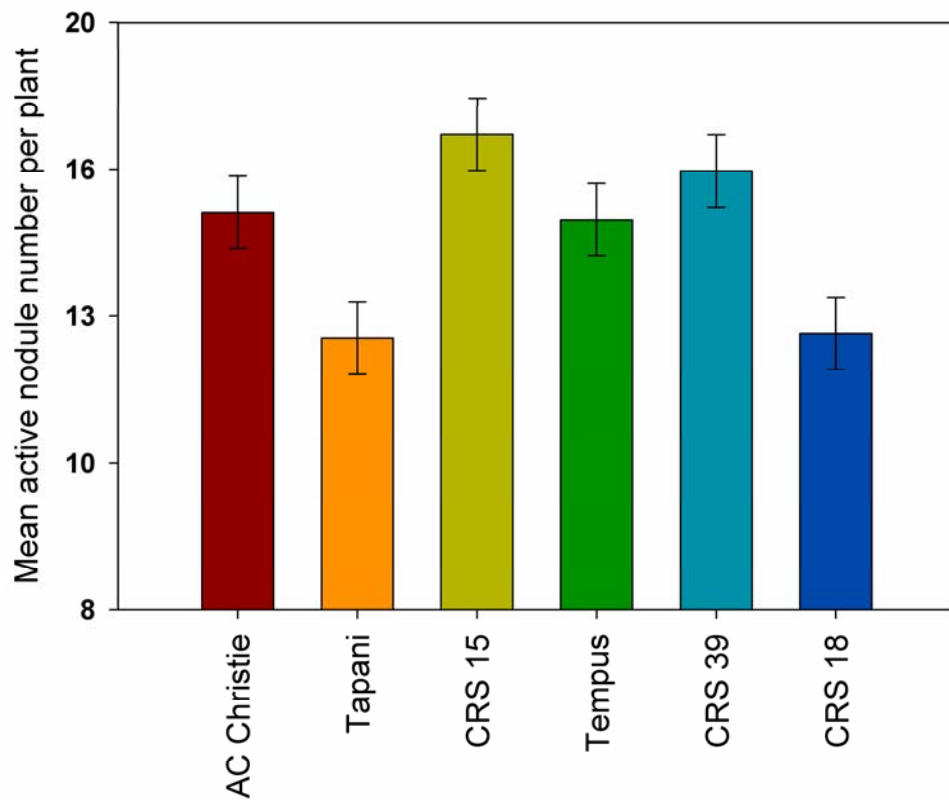


6 × 6 Latin square design, 10 runs

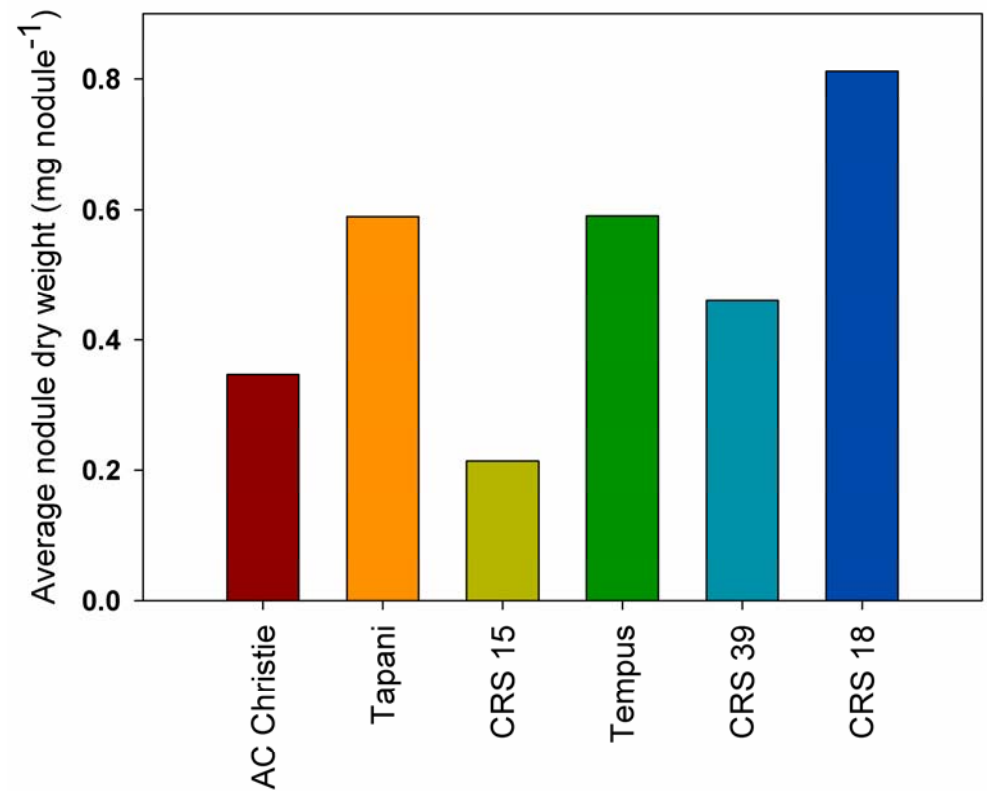


Nodulation

Active Nodule Number



Average Nodule DW



CRS 15 vs Tapani, AC Christie; $p < 0.002$

CRS 15 vs Tapani, AC Christie; $p < 0.002$





AC Christie



Tapani



CRS 15



Tempus

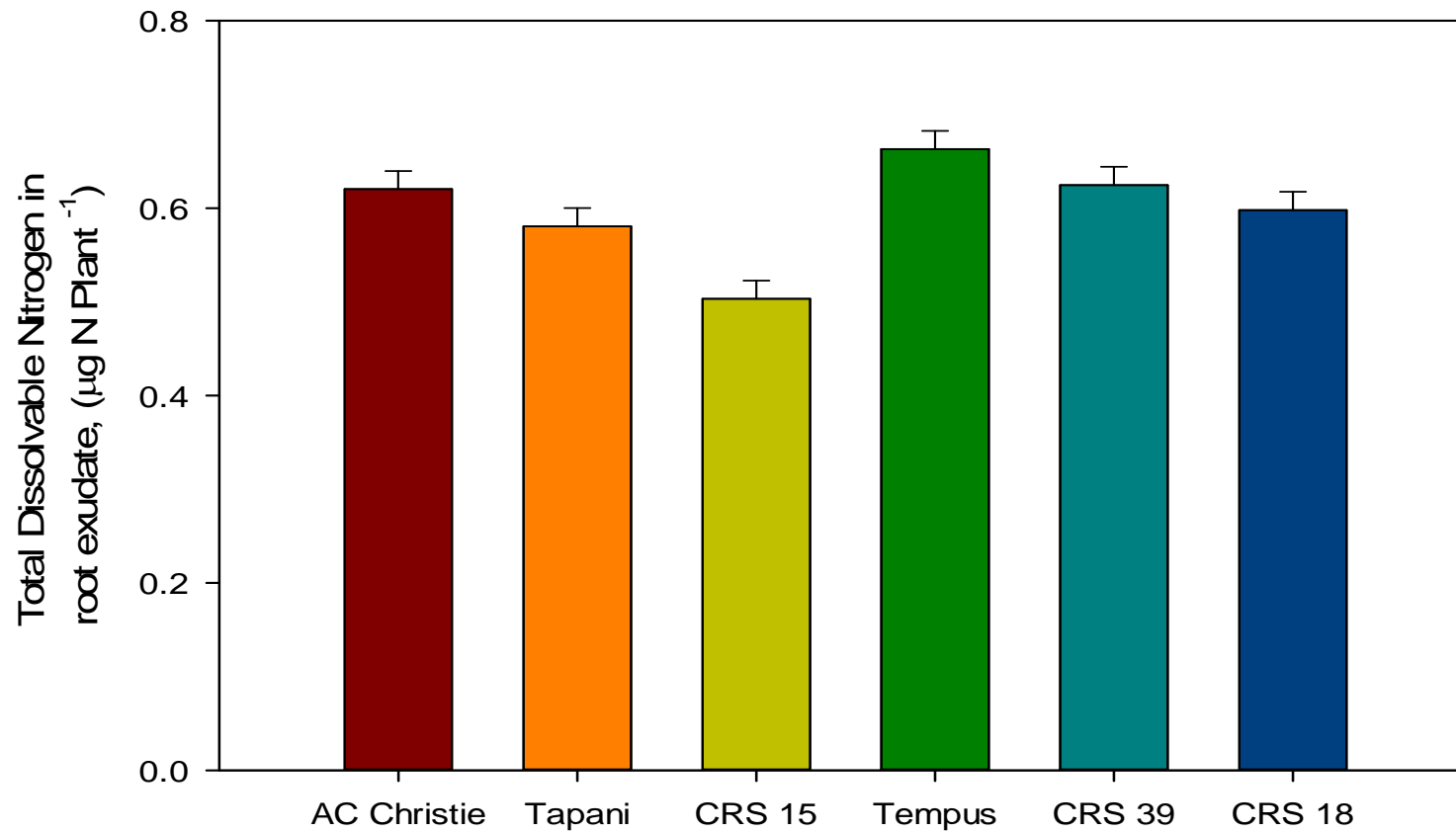


CRS 18



CRS 39

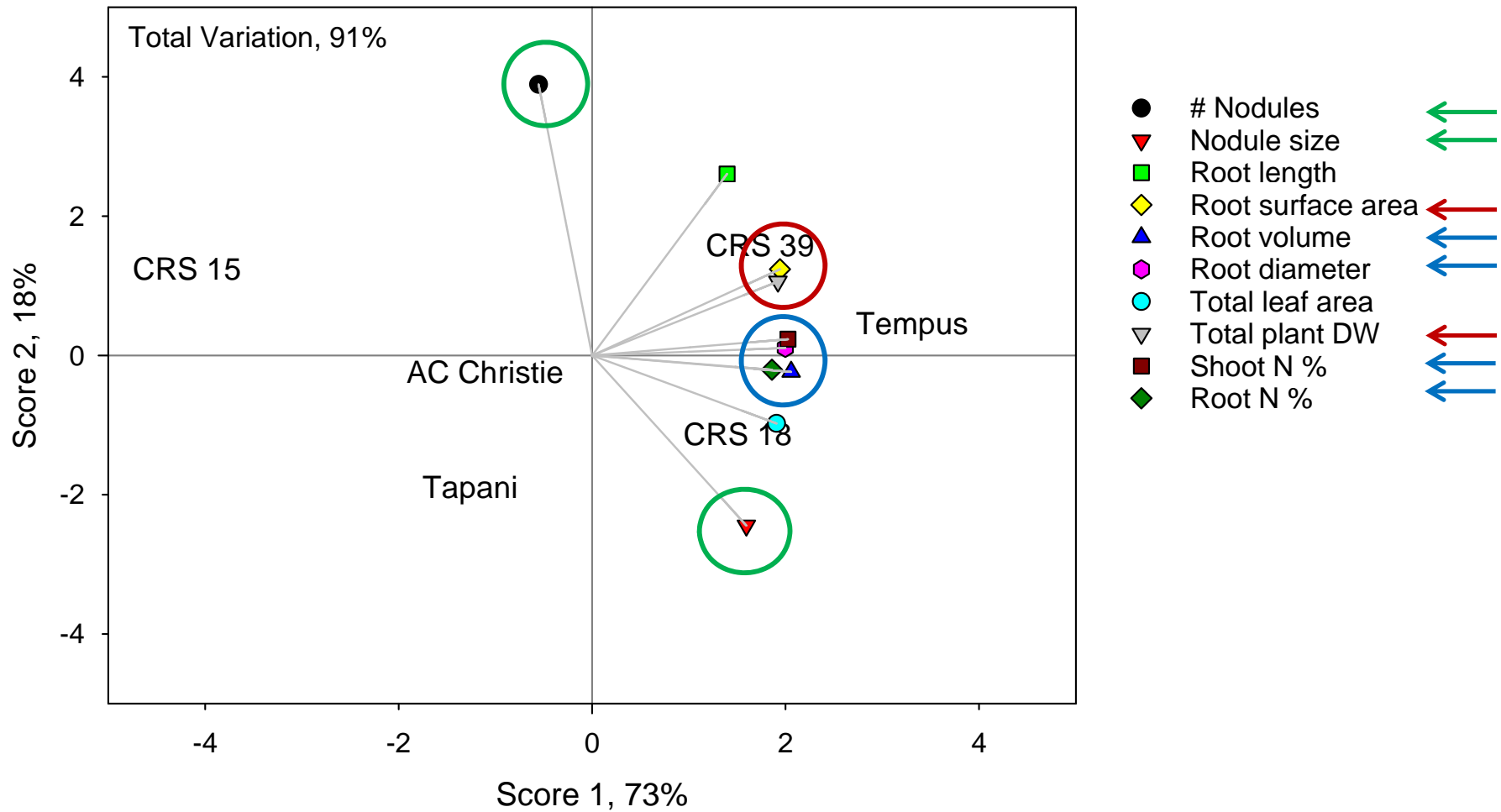
Total Dissolvable Nitrogen



CRS 15 vs Tapani, AC Christie; $p < 0.001$
Tempus vs CRS 39, CRS 19; $p = 0.035$



Principle Component Analysis



Conclusion

- All of the selected RC cultivars are efficient in N fixation in the absence of nitrogen fertilizer.
- During the early stages of plant establishment legume genotype plays a major role in determining:
 - Effective early nodulation
 - Plant nodule number
 - Nodule size
 - Amount of N fixation
 - Amount of N exudation



Conclusion

- In the absence of nitrogen fertilizer, the amount of N fixation during the early stages of plant development was positively correlated with:
 - Nodule size
 - Root surface area and volume
 - Total plant DM yield
 - Shoot and root N content.
- In the absence of nitrogen fertilizer, nodule size was negatively correlated with the number of nodules.



Take Home Message

- There is great potential to use different red clover cultivars to help in reducing the need for addition of chemical fertilizers during the early stages of seedling development.



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Thank you!

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