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Context

In Mediterranean region, summer droughts are getting more intense with climate change, and water management is essential to avoid grapevine water and nitrogen (N) stress in order to maintain berry production (Celette and Gary 2013). Service crops provide services in vineyards, eventually in relation to water and N supply (Garcia et al. 2018). Functional characterization is increasingly employed for cultivated ecosystems (Martin and Isaac 2015; Wood et al. 2015), with the hypothesis that functional markers could help us to predict the ecosystem services provided by cash crops and service crops (Damour et al. 2015). However, there is a lack of studies that assess the relations between functional markers and ecosystem services in field conditions.

Objective: to test the relations between functional markers of service crops and soil water and nitrogen stocks in vineyards



Figure 1: Fababeen covercrop in a Mediterranean vineyard © Yvan Bouisson, UMR System, February 2016

Material and methods

- Vineyard located in the South of France, calcareous cambisol with 30% clay and 40% silt
- 38 different communities composed of one species of service crop and spontaneous species in the inter-rows

November 2016
(service crop emergence)

April 2017
(grapevine budburst, service crop destruction)



- At service crop emergence:** Soil cores to measure soil N contents
- At grapevine budburst,**
 - Flora inventory,** cover rate and aboveground biomass,
 - Soil cores to measure soil water and N contents (1 m deep)
 - Aboveground functional markers** (plant height, leaf area, leaf dry matter content, plant dry matter content, specific leaf area (SLA), carbon, N content and C/N ratio) measured on sown species and most frequent weeds (39 species in total) according to standardized protocols (Pérez-Harguindeguy et al. 2013). Community weighted means CWM (Garnier et al. 2004) calculated for each aboveground marker to take into account species diversity in each quadrat.
 - Root functional markers** measured from soil cores: Root mass density (RMD, kg m⁻³), root length density (RLD, cm cm⁻³), mean diameter (DIAM), Specific root length (SRL, m g⁻¹), very fine root fraction (VFRf) for deep (d) and shallow (sh) soil layers

Results and highlights

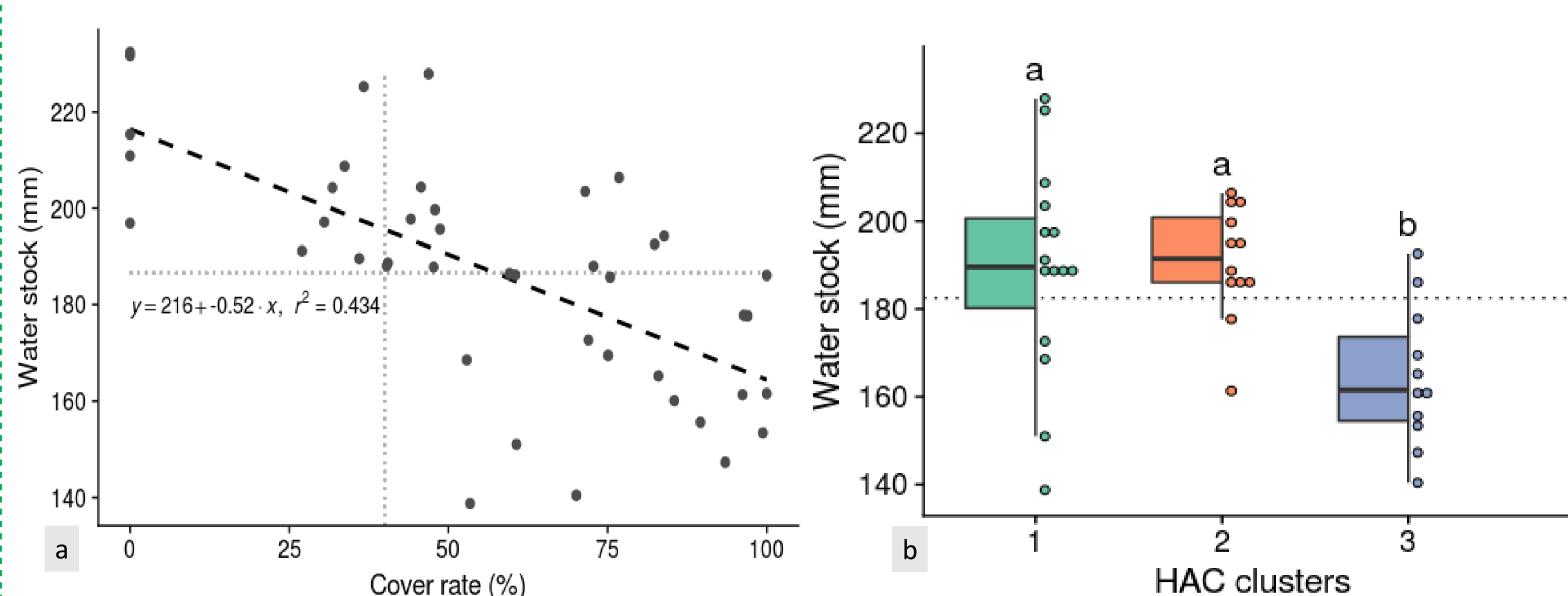
1. Temporary service crops deeply modify soil water and nitrogen status at budburst

Method: descriptive statistics for the 38 service crops quadrats

	Service crops characteristics		Soil services indicators	
	At grapevine budburst		At grapevine budburst	
	Cover rate (%)	Total Biomass (g)	Water stock (mm)	Mineral N stock (kg N/ha)
Mean	64,87	85,16	182,53	6,64
Min	27,00	28,15	138,75	0,42
Max	100,00	369,01	227,93	34,41
Coefficient of Variation	0,35	0,82	0,11	1,11

2. Soil water stocks are related to soil cover rate and to the functional markers of the service crops and associated weeds.

Methods: regression analysis (2a) and cluster analysis (2b) using HAC, following a PCA on the functional markers that showed significant correlations with the water stock and the cover rate



Cluster 1: high dry matter content, high specific root length and very fine roots for shallow roots, dominated by Poaceae and Hydrophyllaceae species

Cluster 2: high leaf dry matter content, thin deep roots and high shallow roots diameter and density dominated by Asteraceae species

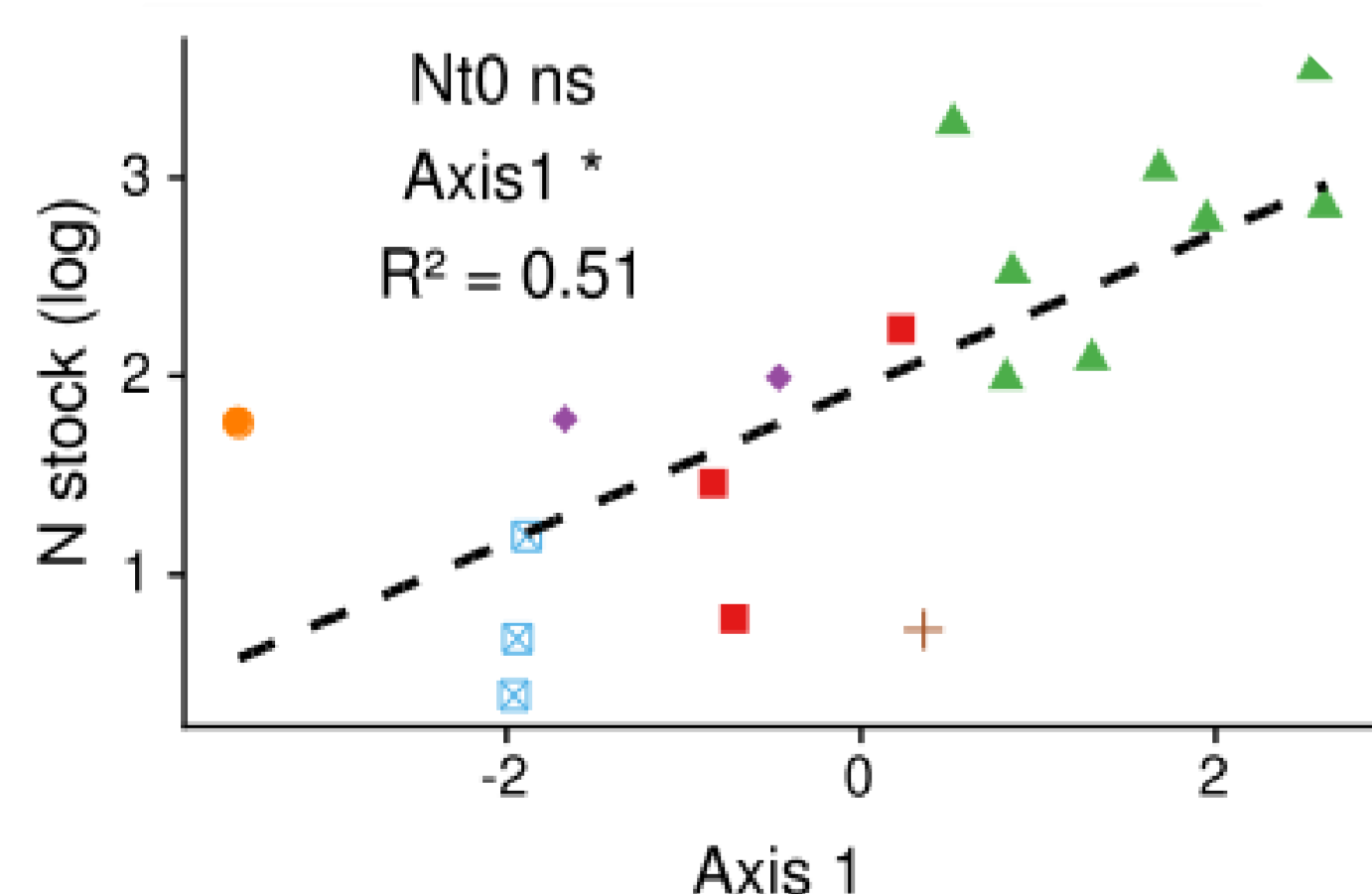
Cluster 3: deep roots, thick roots, high density in deep layers, low dry matter, dominated by Fabaceae species

3. Soil mineral N stocks are related to the soil mineral nitrogen content at service crop emergence and functional markers of the service crops and associated weeds.

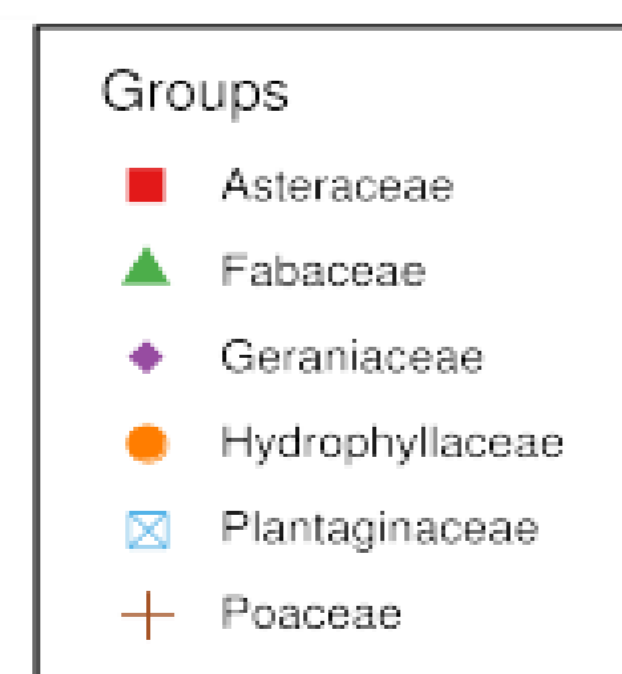
Methods: regression between PCA coordinates based on aboveground and root markers and soil N mineral stock at budburst

$$\text{Soil mineral N stocks at grapevine budburst} = f(\text{Soil mineral N stocks at service crop emergence}; \text{Axis 1 of PCA (SLA, LNC, N)})$$

For the whole dataset



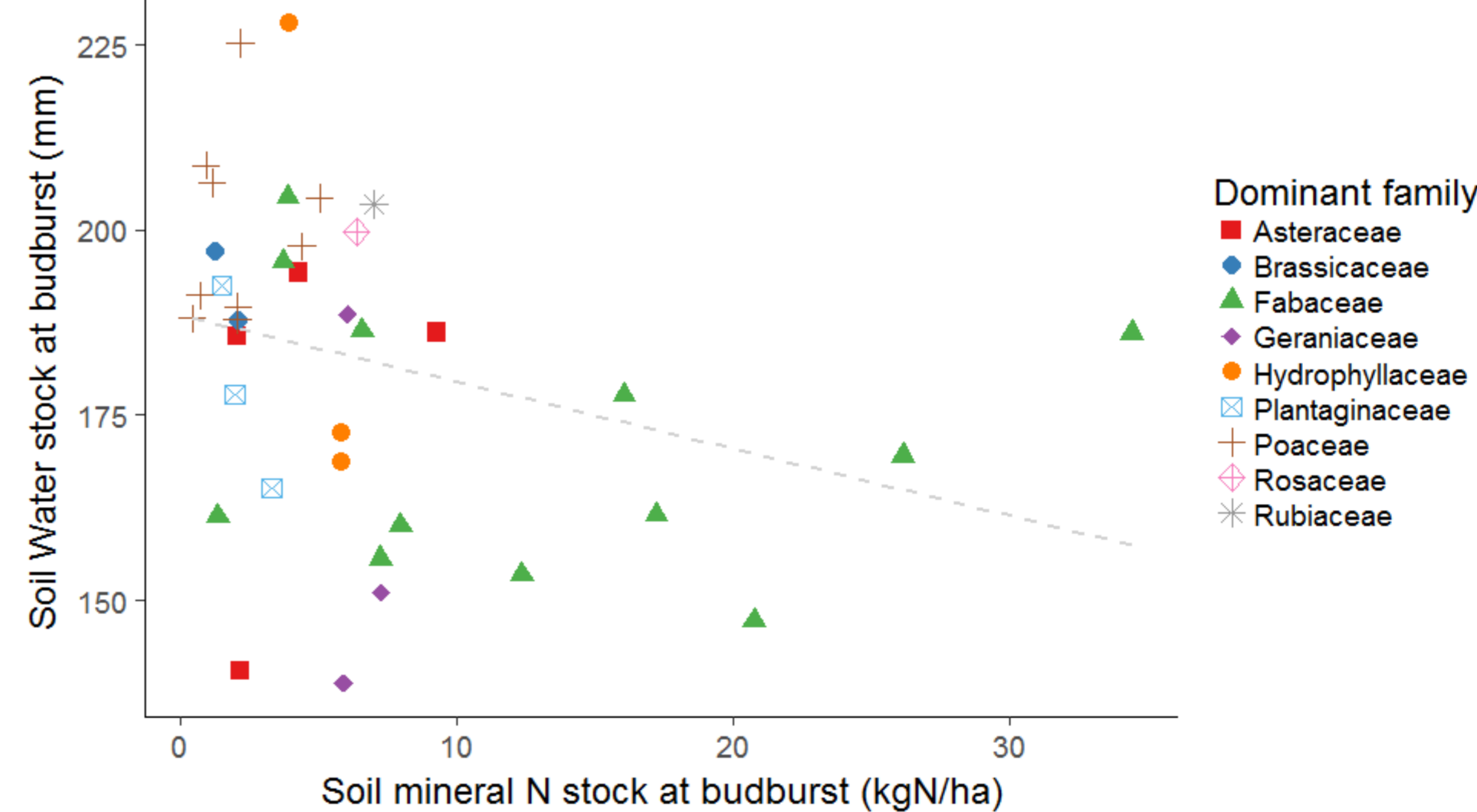
For 6-year-old service crops plots only



- Axis 1 correlated with SLA: specific leaf area; N: plant nitrogen content and CN of the plant community was significant with a positive effect on N stock.
- Fabaceae clearly increase N stocks at grapevine budburst

4. Trade-off between soil water and nitrogen services

Methods: regression between both soil-based services, considering the different dominant families, for the 38 quadrats



A negative relationship between soil water and nitrogen services, strongly dependant on dominant family

Conclusion

Service-cropped vineyards can be seen as drivers for providing multiple ecosystem services (Gaba et al., 2015). Our results highlight i) simple indicators measured at plant community scale (e.g. cover rate) sufficiently accounts for differences in water provision at budburst; ii) the importance of initial soil conditions to explain short-time scale and highly variable service such as soil mineral nitrogen content; iii) help to discriminate different service crops families regarding their ability to provide soil based ecosystem services and iv) suggest that functional characterization of service crops at plant scale may be relevant and complementary to flora inventory to analyse some ecosystem services.

References

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