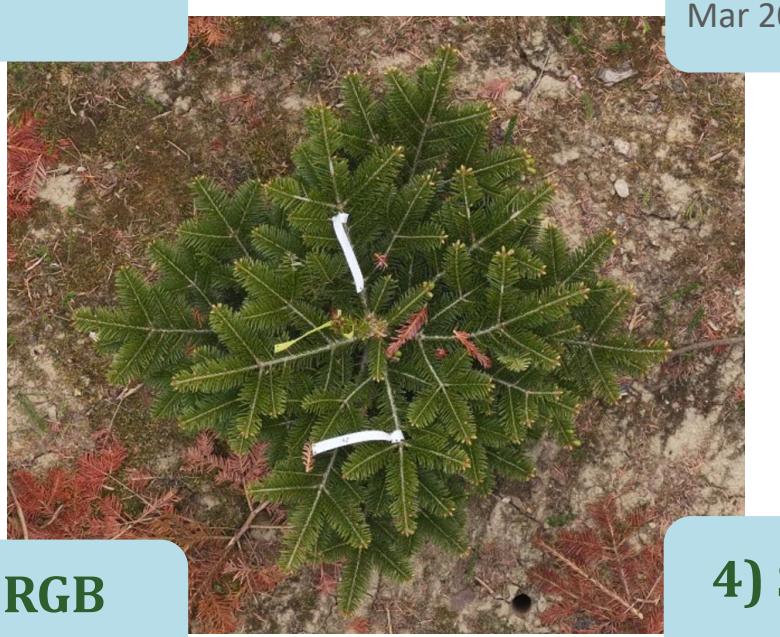
Results from 117 trees intensive study at Lundbygaard

1) Field traits

height, shoots, radius, bare shoulder, colour

Mar 2026



2) Needle samples

C, N + 24 elements

Mar 2026

3) Drone RGB

113 trees

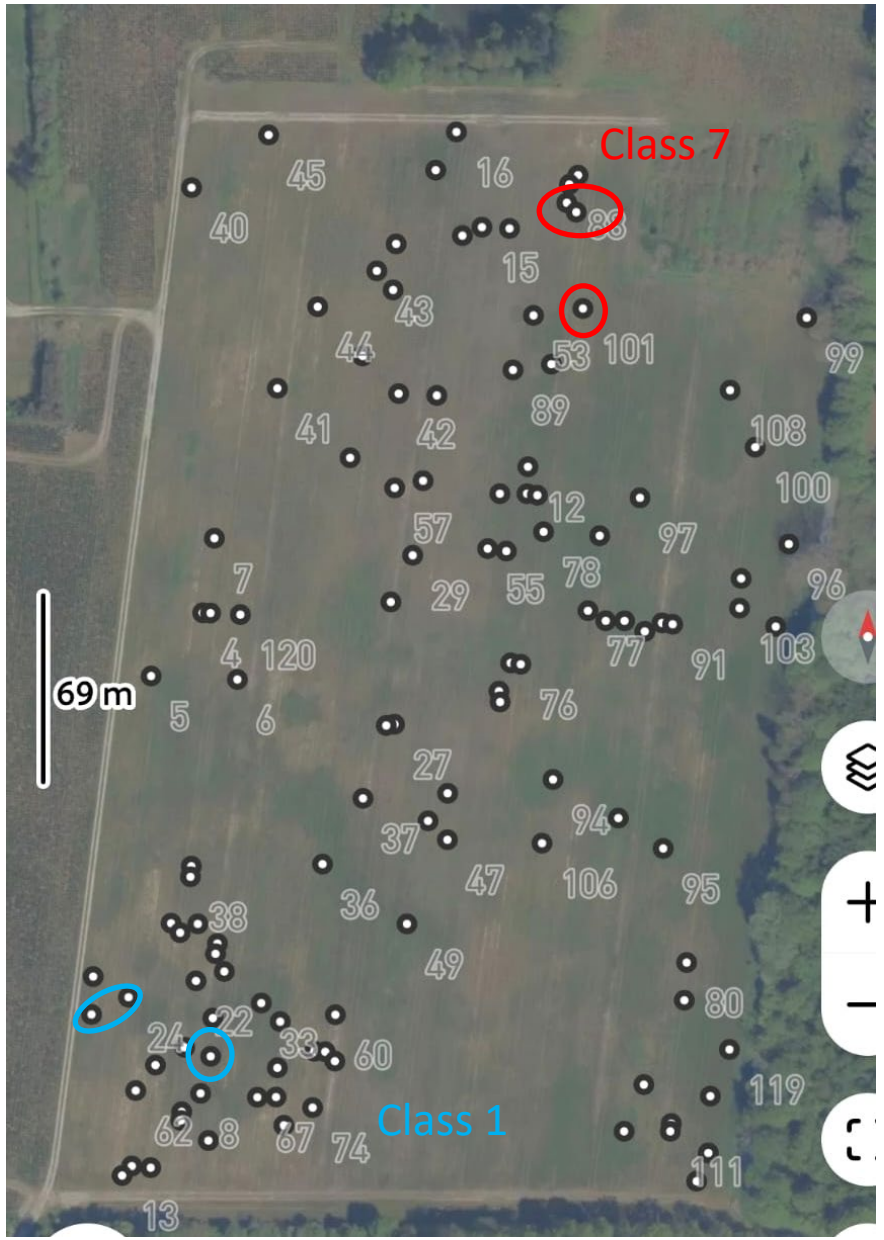
Vegetation indices

19 May 2026

4) Soil

DanAgro map: 12 variables
IGN lab: 6 trees × 2 depths

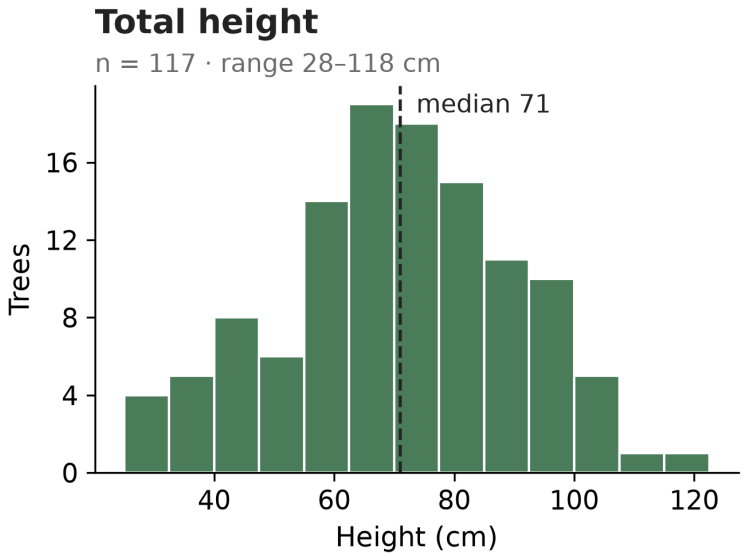
Apr 2026

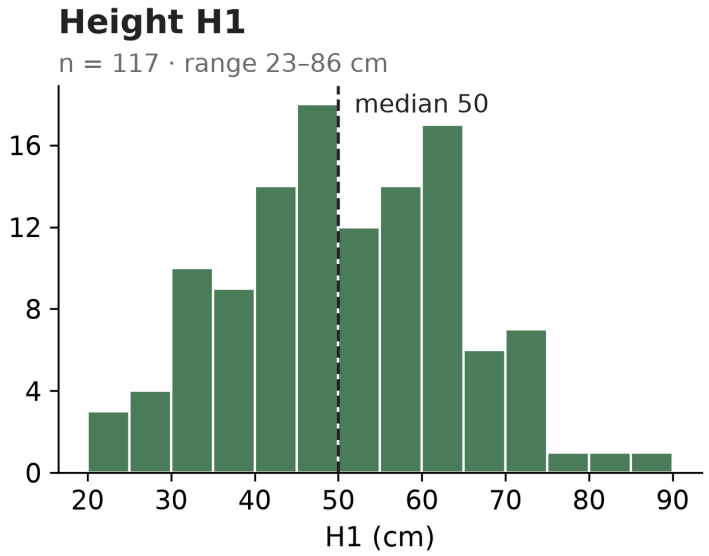


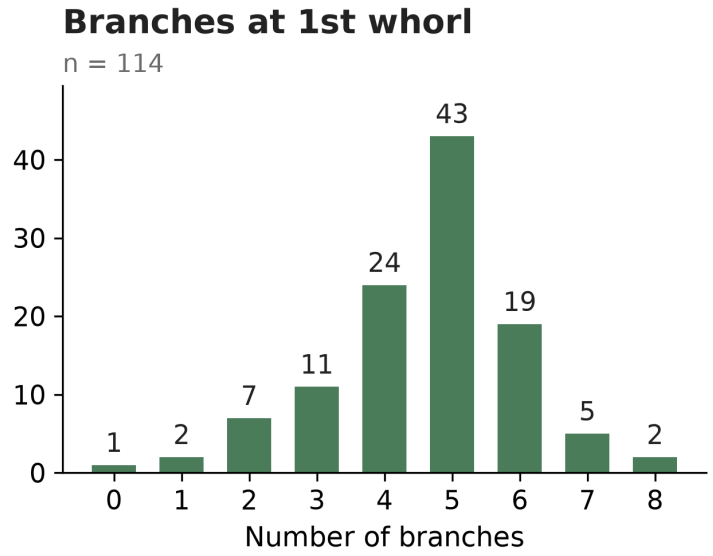
Research questions

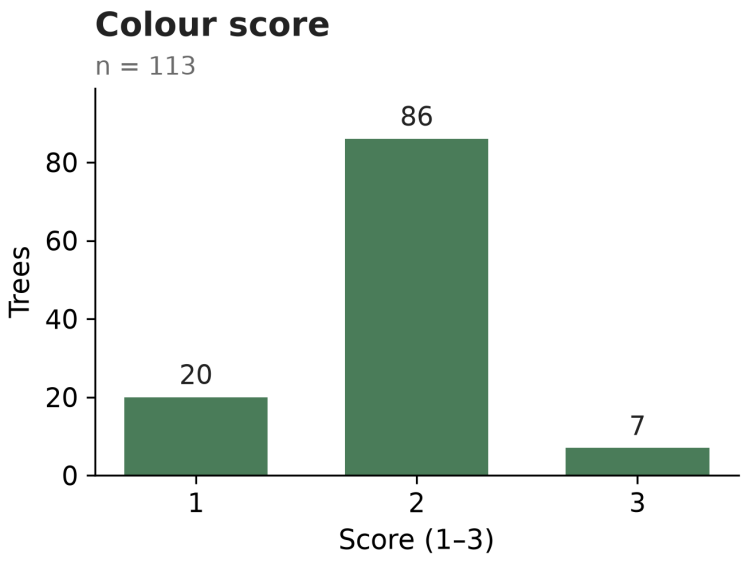
- Q1 Which nutrients related with which traits?
- Q2 Does DanAgro soil explain tree nutrition?
- Q3 Does DanAgro soil explain tree traits?
- Q4 Can the drone see needle nutrient status?
- Q5 Can the drone capture tree traits variation?

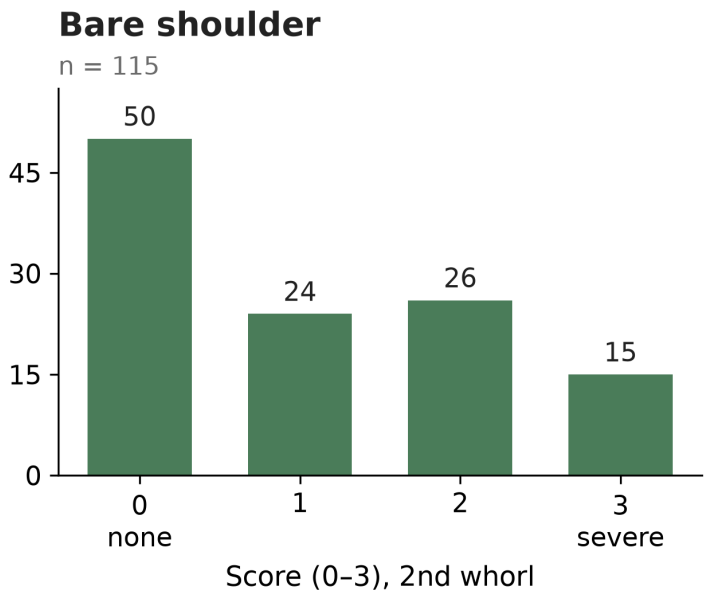
1) Field traits data overview

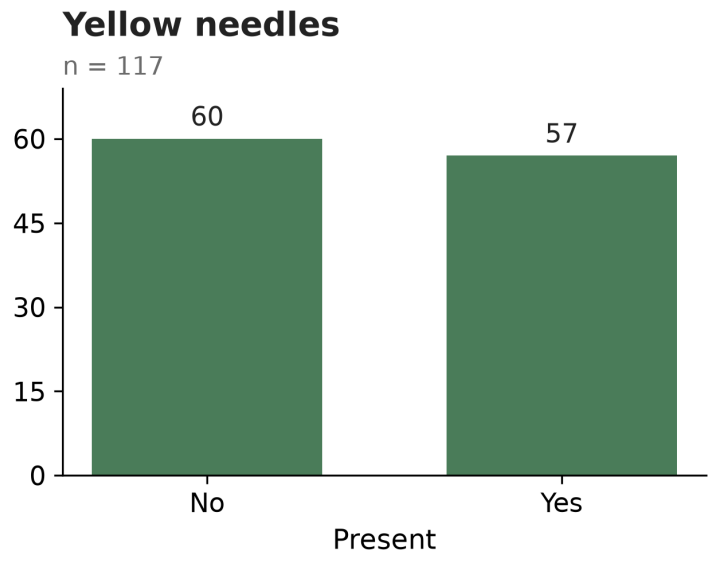










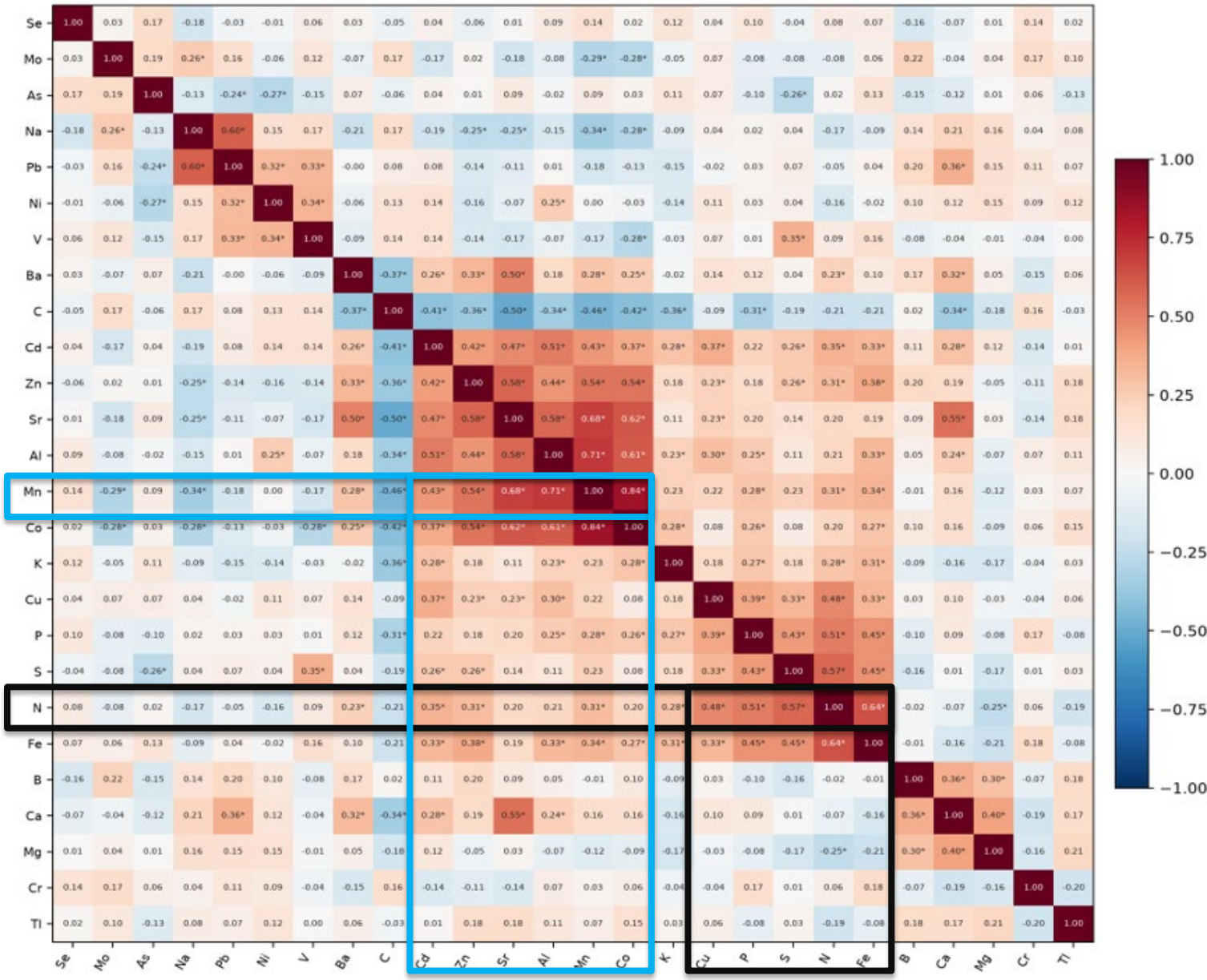


2) Needle samples correlation

Main patterns in the plot:

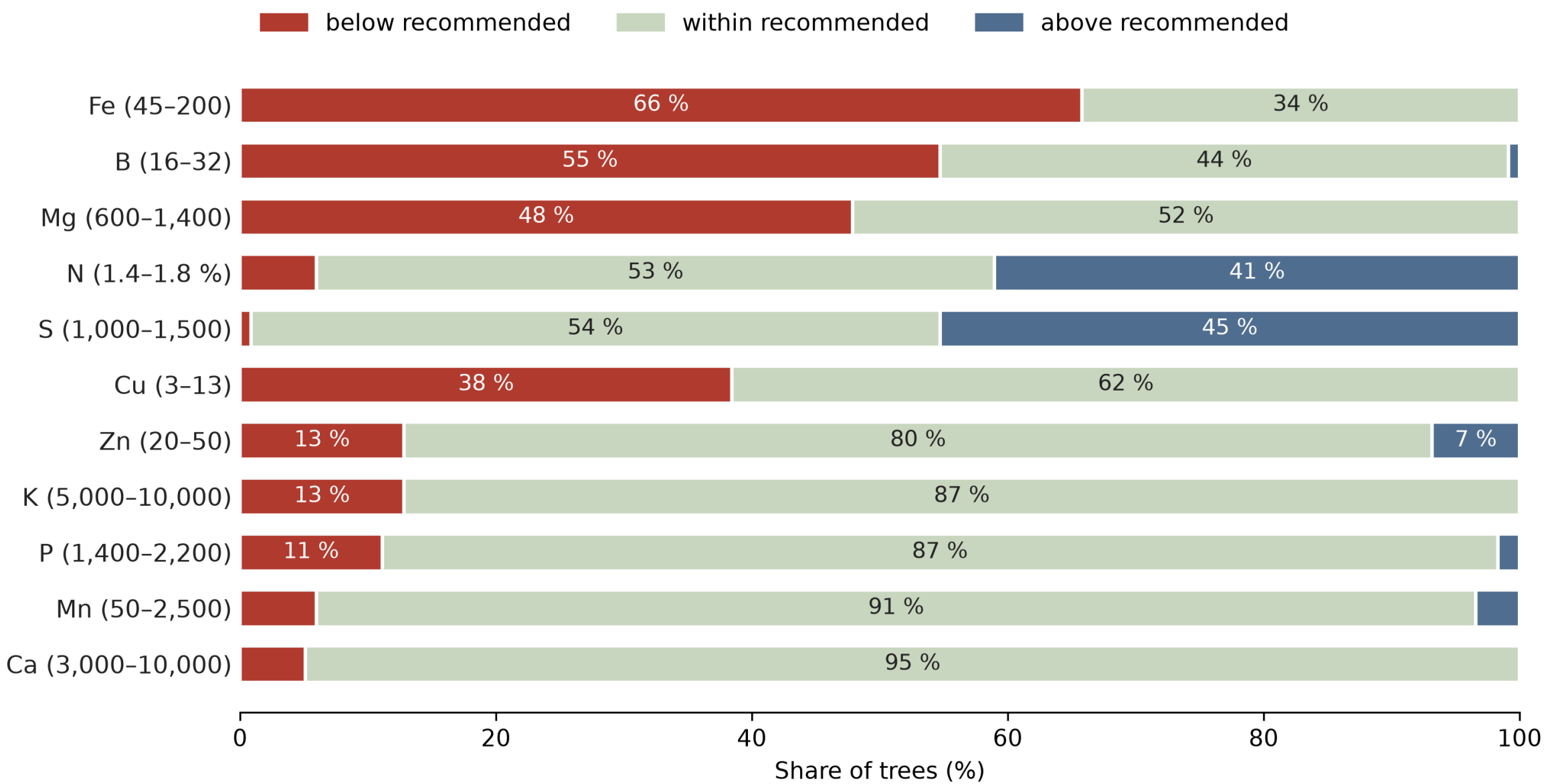
- Mn–Co–Al–Sr–Zn–Cd
  mobile at low soil pH.

- N–P–S–Fe–Cu
  macronutrients tied to protein and photosynthesis, so they reflect nutritional status and growth.



Needle nutrient status of 117 trees against the Danish recommended range

Nordmann fir Christmas trees (Danske Juletræer 2024, Gødningsanbefalinger, table 1). Range in brackets: N in % dry mass, others mg/kg.



3) Drone RGB images processing

1. **Match each photo to its tree using GPS**

2. **Cut out the target tree**

   Separated from neighbouring trees, grass, moss, dead needles on the ground, and the plastic labels.

3. **Vegetation indices**

   Standard colour indices, averaged over every pixel of that tree.

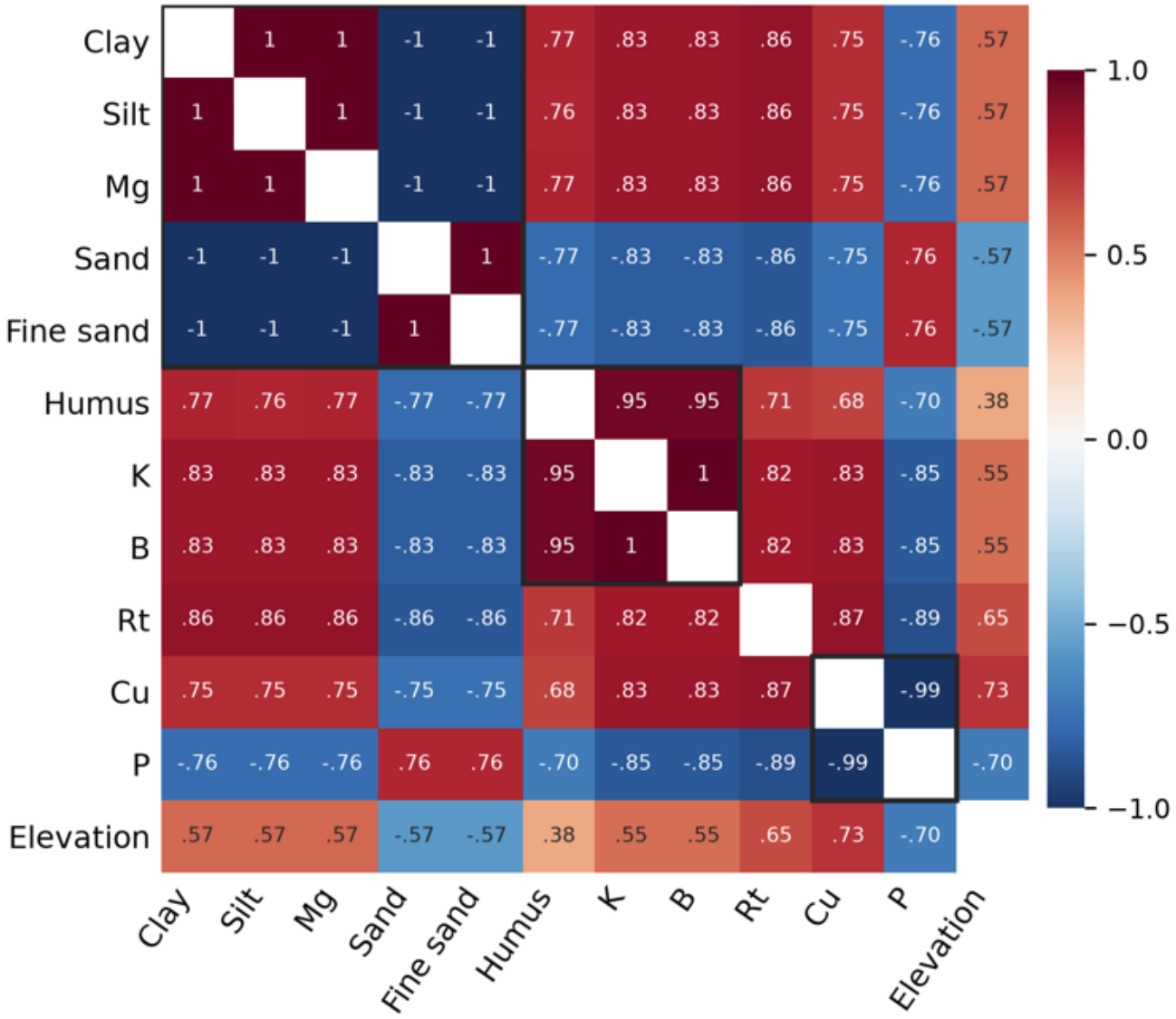
4. **Remove a terrain-driven measurement artefact**

   Essential — without it, apparent colour differences reflect the landscape, not the trees.





4) DanAgro soil data correlation



So the data really hold about 5 independent variables:

-texture

-humus/K/B

-Rt

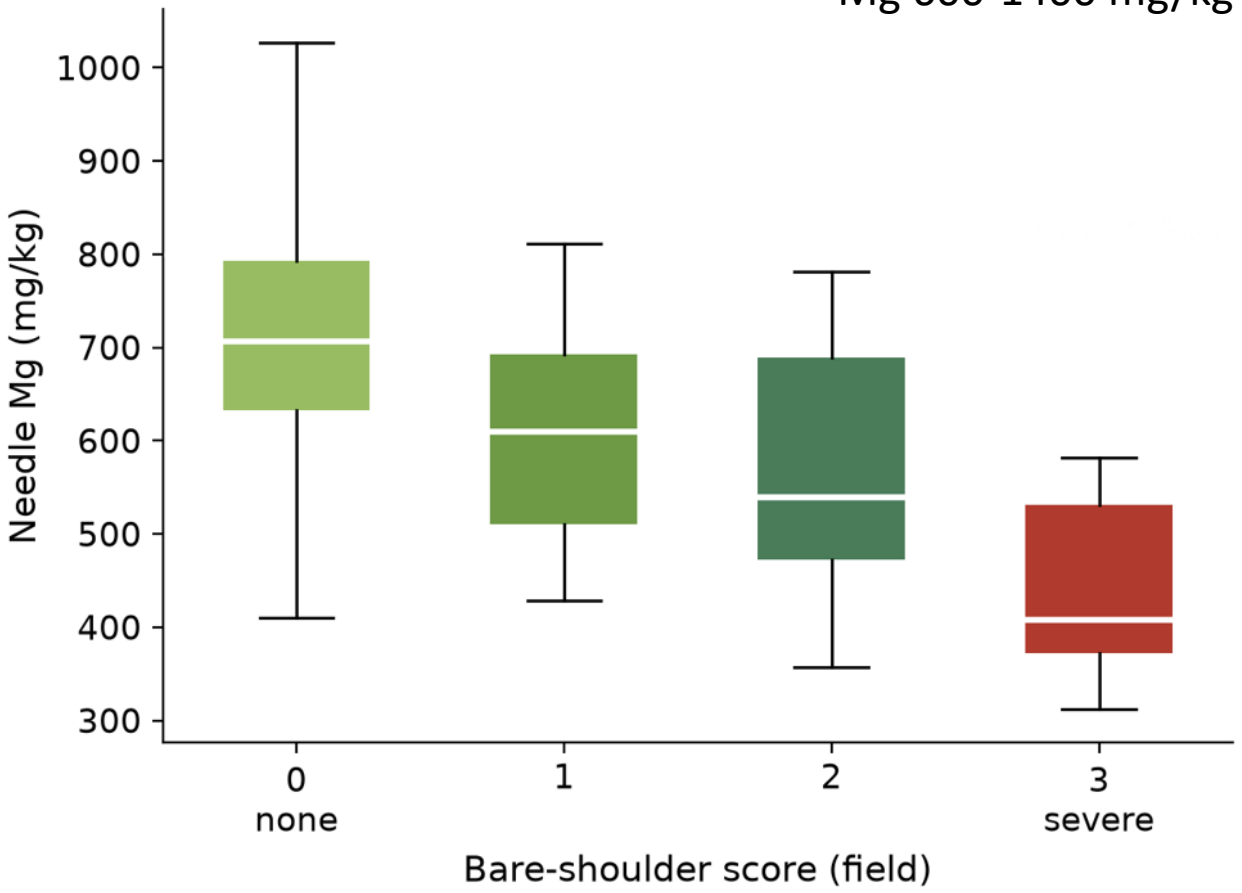
-Cu/P

-elevation

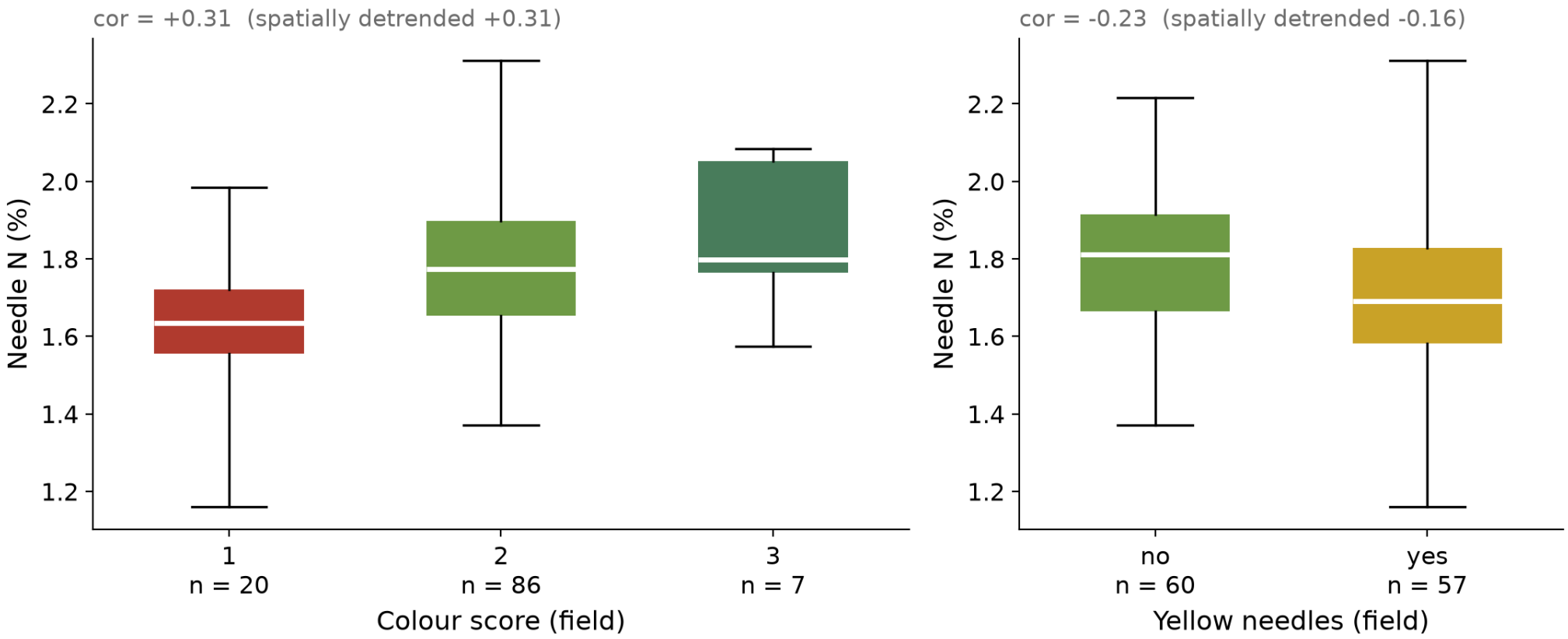
Q1: Which nutrients related with which traits?

Trait	Needle	Cor
Bare shoulder	Mg	-0.46
Bare shoulder	Fe	+0.25
Bare shoulder	S	+0.25
Bare shoulder	P	+0.30
Colour score	N	+0.31
H1	P	+0.27

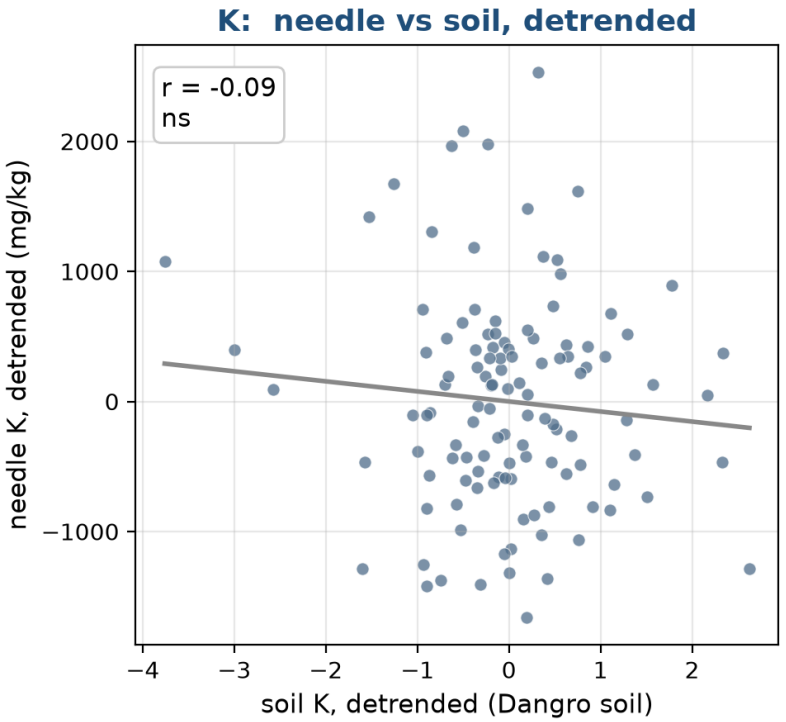
Mg 600-1400 mg/kg

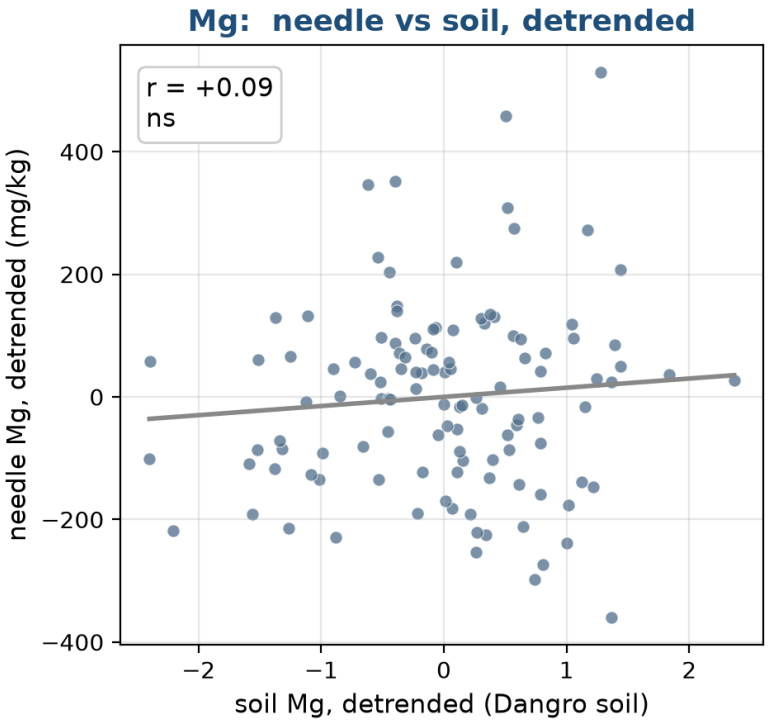


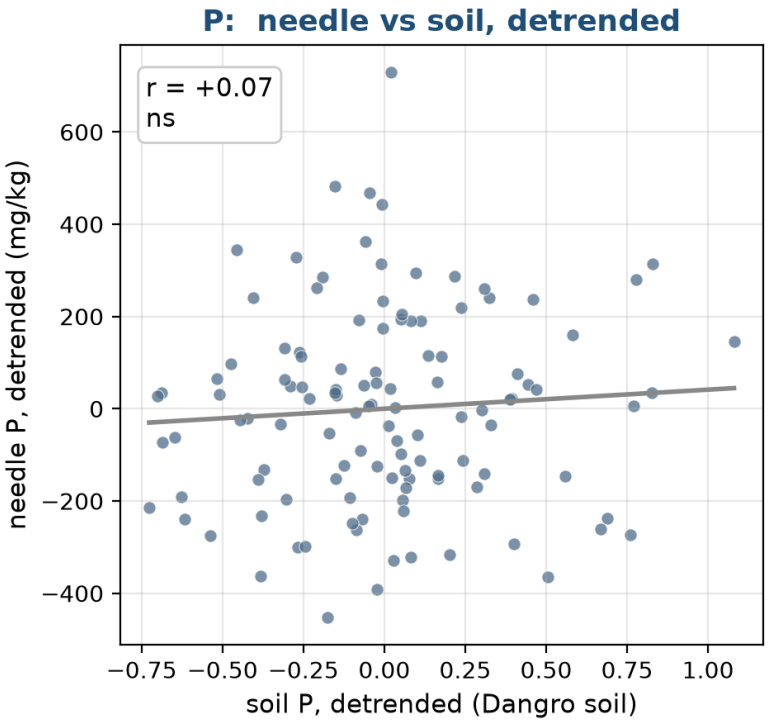
Needle colour in the field follows needle N



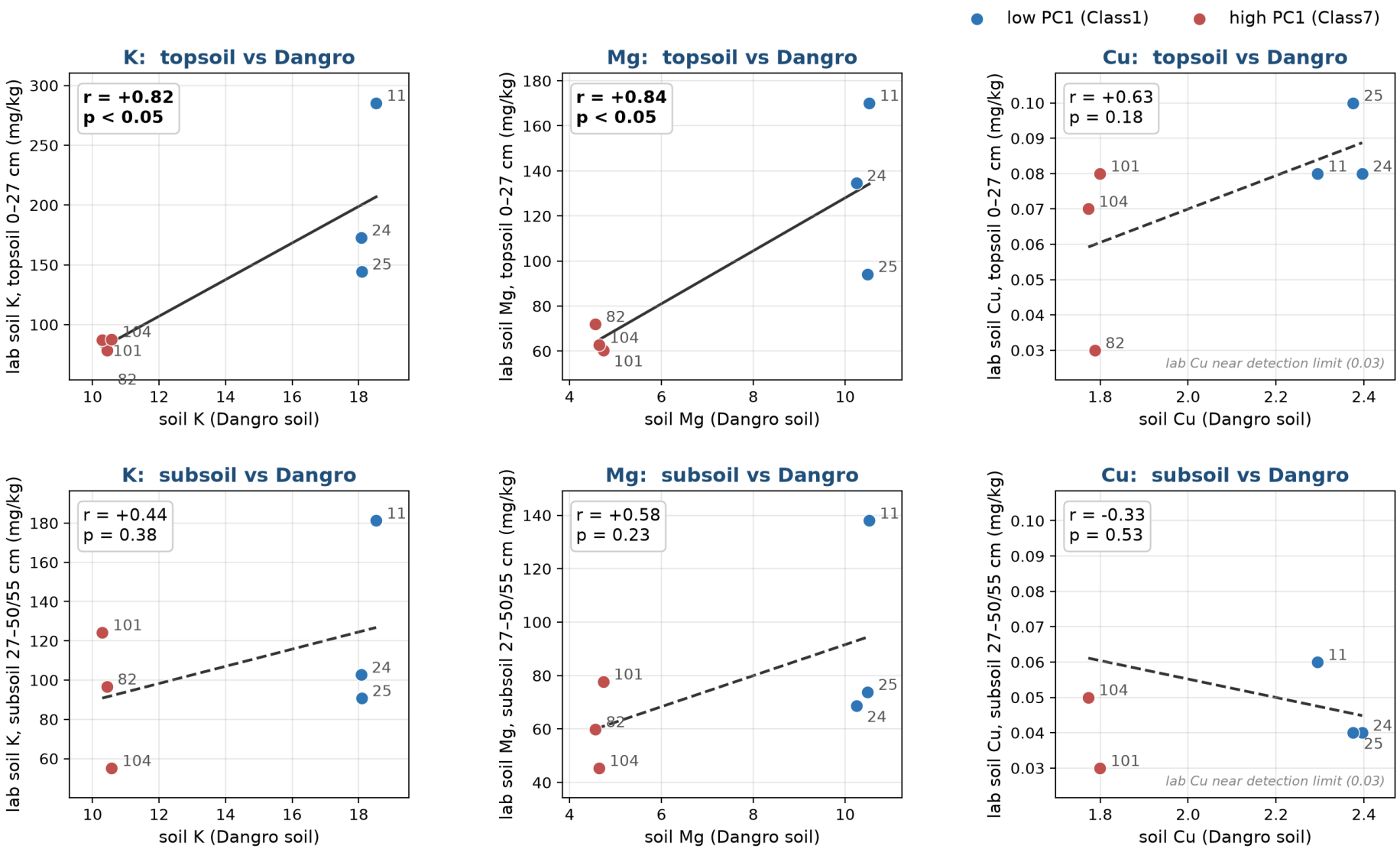
Q2: Does DanAgro soil explain tree nutrition?



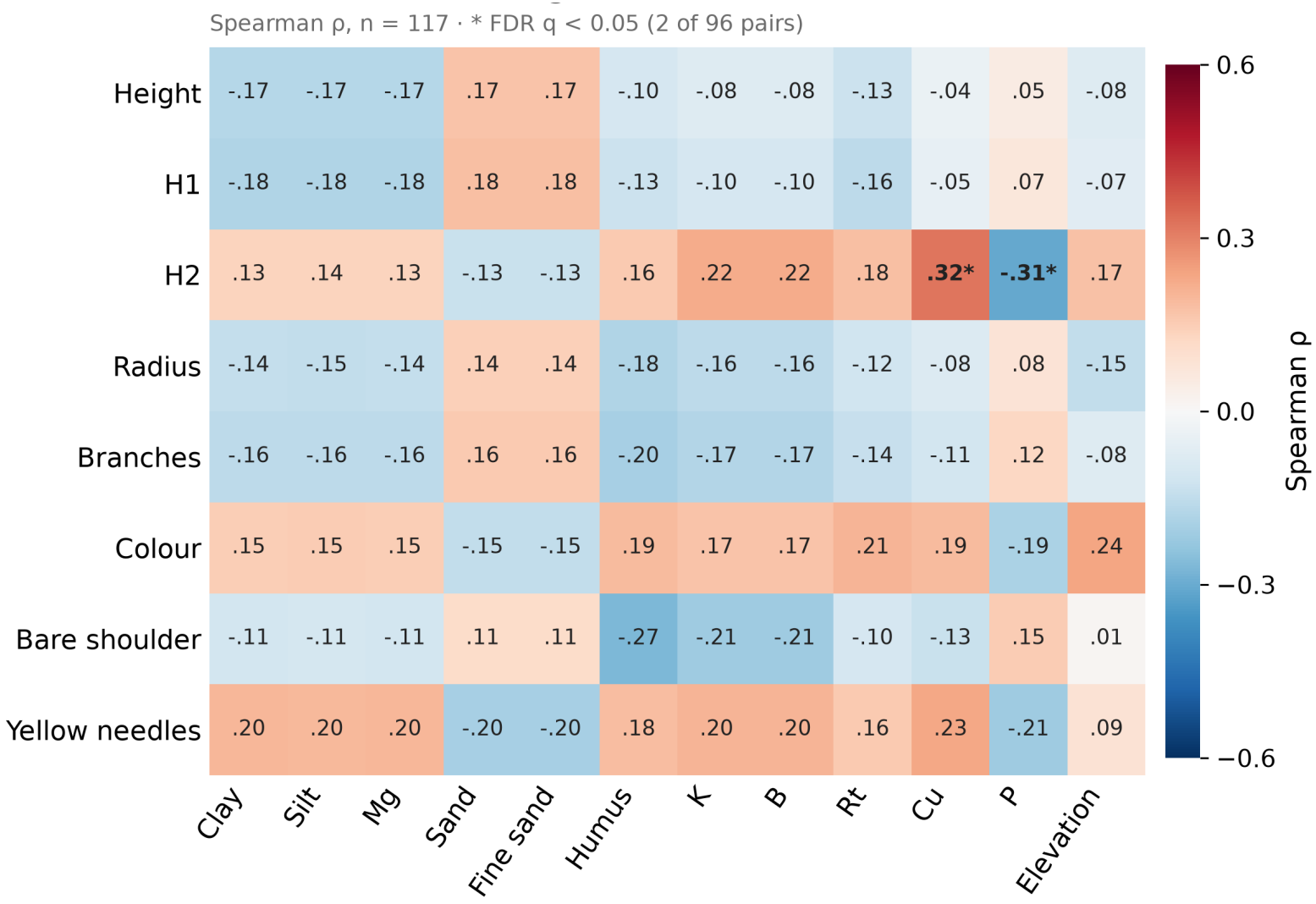




IGN lab soil: median topsoil / subsoil ratio (6 trees)



Q3: Does DanAgro soil explain tree traits?



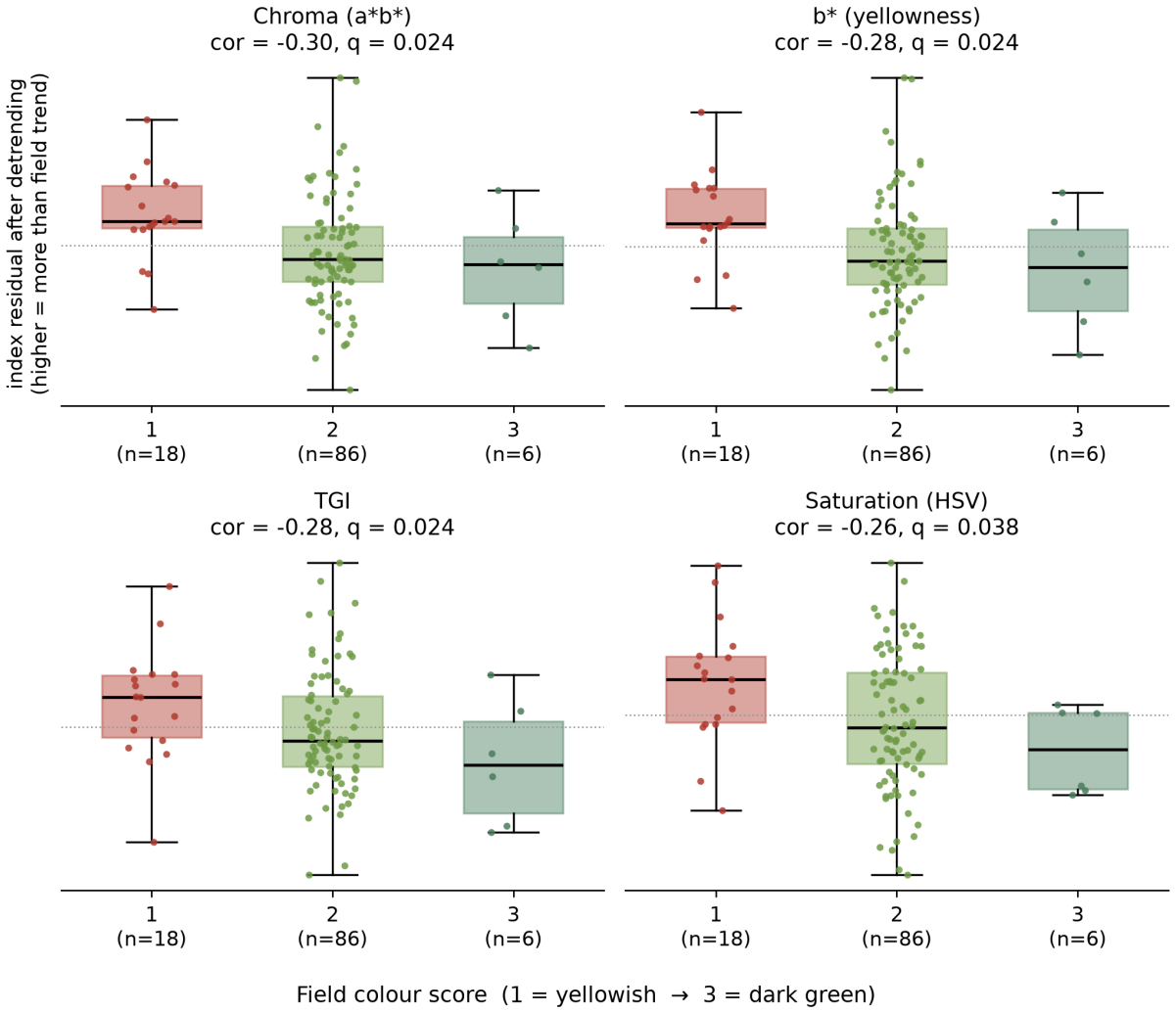
Q4: Can the drone see needle nutrient status?

Nutrient	Best index	r	Predictable?
N	Saturation	-0.62	**yes**
S	RGBVI	-0.41	weak
Fe	Saturation	-0.45	weak
Mn	b* (yellowness)	-0.38	weak
Cu	Chroma	-0.40	weak
Zn	b* (yellowness)	-0.35	weak
Mg	RGBVI	0.32	weak

Yes: N (cross-validated R^2 0.28).

Weak: S, Fe, Mn, Cu, Zn, Mg; these share the colour signal of N or of acid soil.

Q5: Can the drone capture tree traits variation?



The colour score itself follows needle N (detrended cor = 0.28), so the drone and the eye react to the same N-related yellowing.

Summary

- Q1 Which nutrients related with which traits? Mg and N
- Q2 Does DanAgro soil explain tree nutrition? No
- Q3 Does DanAgro soil explain tree traits? No
- Q4 Can the drone see needle nutrient status? Yes, N
- Q5 Can the drone capture tree traits variation? Yes, N related needle yellowness