Tree nutrient status by bark analysis: first results from a soil moisture site gradient across Switzerland

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Tree nutrient status by bark analysis – why?

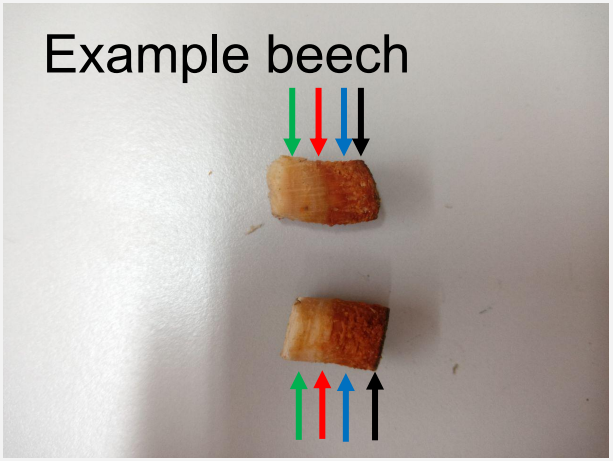
- Thresholds of foliar nutrient concentrations are often used as diagnostic tool to assess the nutritional status of trees.
- As such they have been employed to interpret monitoring results *(e.g. Jonard et al. (2015), Global Change Biol 21, 418)* or as decision support for protective measures *(e.g. Hüttl (1992), Freib. Bodenkundl. Abh. 30, 31; Moore et al. (2000) Can J For Res 30, 725)*
- The tresholds are based on empirical relationships between nutrient concentrations in leaves or needles and phenological deficiency symptoms or plant growth.
- Often used values published by Mellert and Göttlein *(2012; Eur J For Res 131, 1461)*, mainly based on a data compilation by van den Burg *(1985, 1990)*

Tree nutrient status by bark analysis – why?

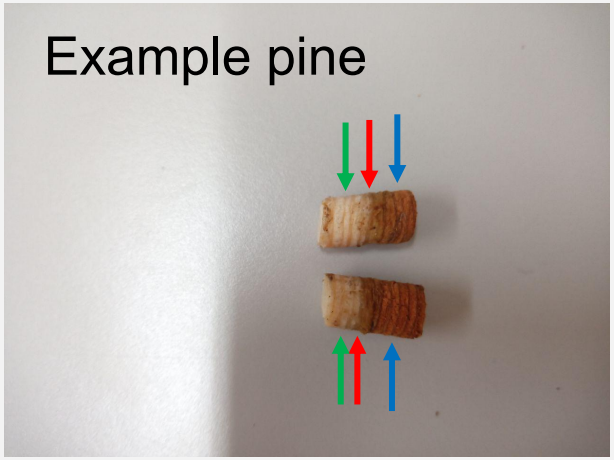
	Foliage	**inner Bark**
Sampling	Requires climbing	„easy“ in breast height
Contamination	Exposed	Protected by outer bark layers
Temporal and spatial variation	seasonal → narrow, defined time window for sampling inter-annual → proper interpretation needs samples from several years gradients within tree canopy → well defined location	First experience *(Ettl and Göttlein, TU Munich)*: • some variations during summer • little variations during winter → propose winter sampling for all tree species • integrates over several years (!?)
Relation to soil nutrient supply	Often weak *(e.g. Talkner et al. (2015), Ann For Sci 72, 919; Meller et al. (2019), Frontiers Plant Sci 10, #744)*	???

Tree nutrient status by bark analysis – sampling

xylem
cambium
phloem
cork



- Removal of cork (in particular for oak and pine)
- Sampling of core in breast height with a hollow punch



Method: Ettl and Göttlein, TU Munich

Tree nutrient status by bark analysis – preparation

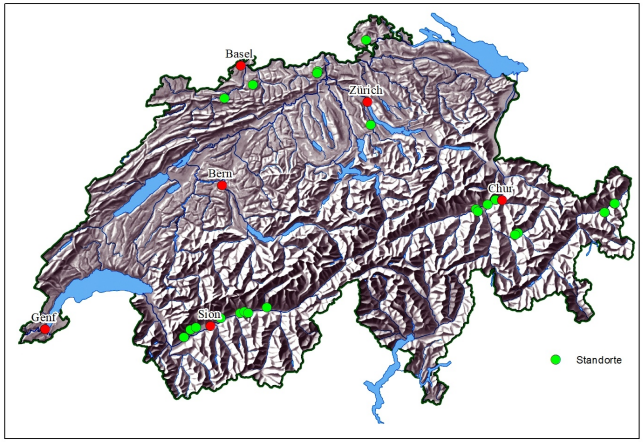
Remove xylem

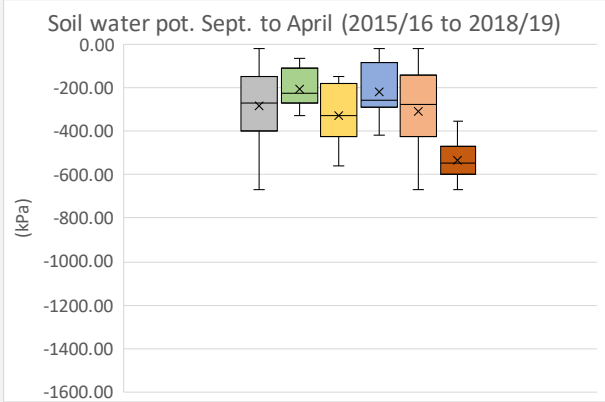
take inner 2 mm of bark (cambium plus part of phloem)

cut disc into pieces for direct elemental analysis

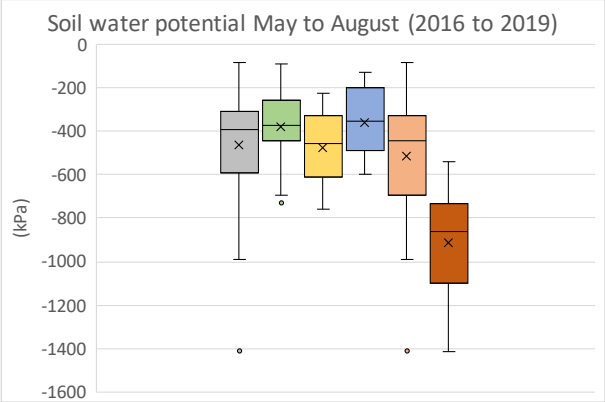
Method: Ettl and Göttlein, TU Munich

Soil moisture „gradient“



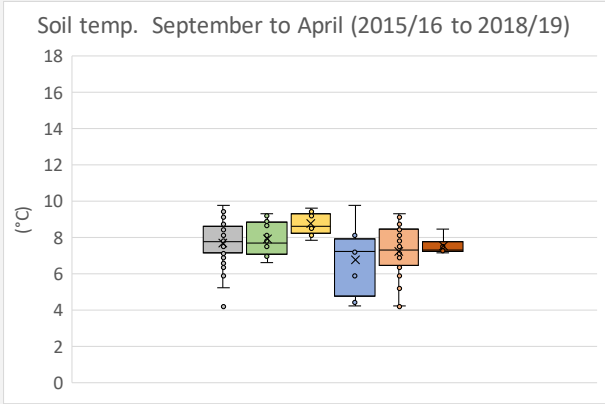


driest: Pfynwald 7, Irr. Stop, Pine
wettest: Surava, N, Pine and Spruce

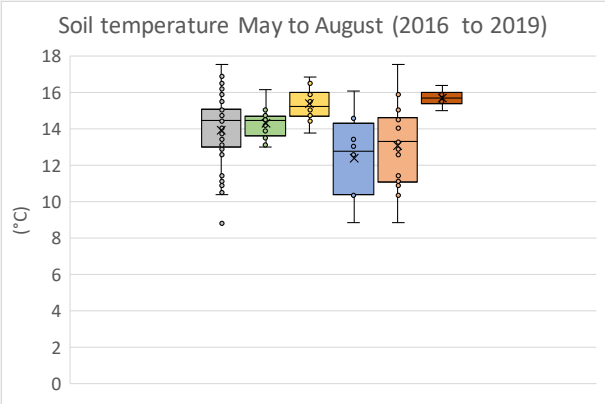


driest: Pfynwald 4, Control, Pine
wettest: Surava, N, Pine

- All sites
- Beech sites
- Oak sites
- Spruce sites
- Pine sites
- Pfynwald experiment

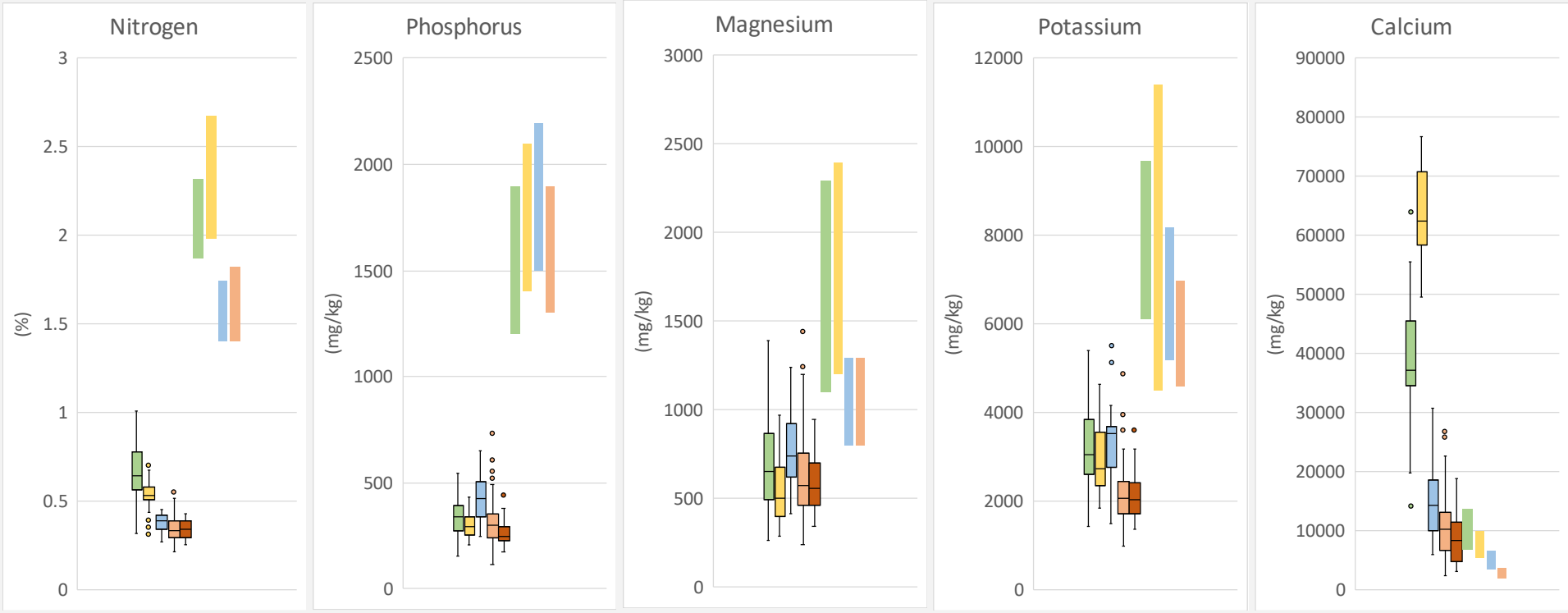


warmest: Pulligen, Spruce
coldest: Scuol, Pine



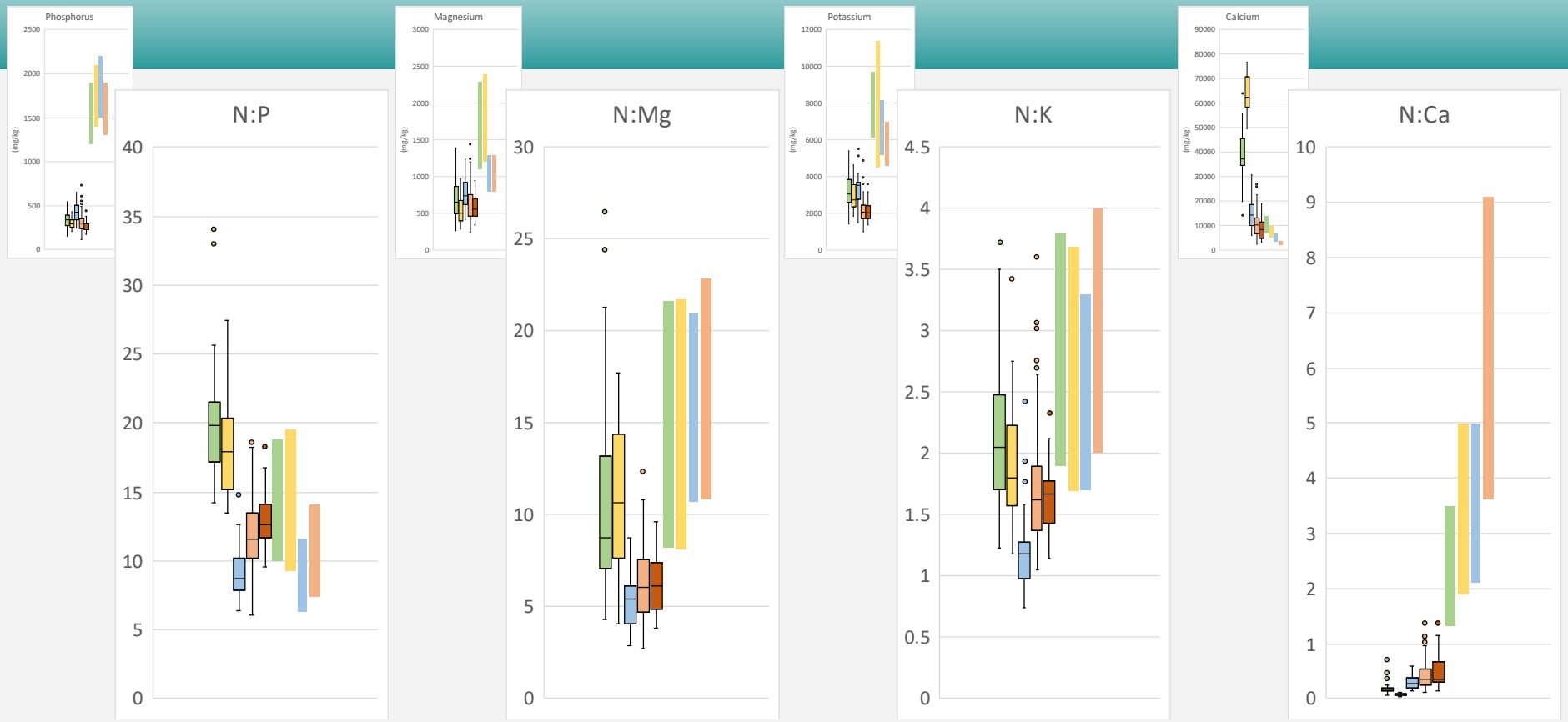
warmest: Chippis, Pine
coldest: Tarasp, Spruce

Nutrient concentrations in bark vs. foliage



- bark beech
- bark oak
- bark spruce
- bark pine
- bark pine Pfynwald exp.
- normal range beech leaves
- normal range oak leaves
- normal range spruce needles
- normal range pine needles

Nutrient ratios in bark vs. foliage



Nutrient concentrations in bark vs. nutrients in soil and soil environmental conditions

Nutrients in mineral topsoil

Water potential (WP) and temperature (ST) in mineral topsoil (2015 to 2019)

Significant positive (green) or negative (red) correlation based on either nutrient or N:nutrient or both in bark

Weakly positive (green) or negative (red) based on both nutrient and N:nutrient in bark

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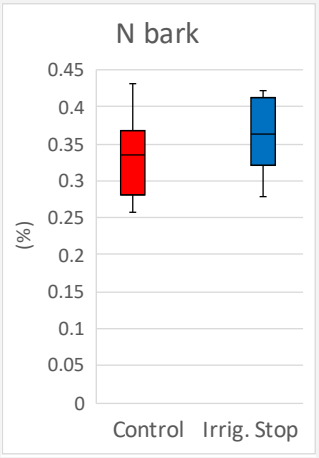
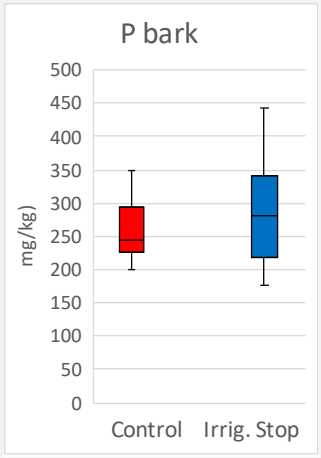
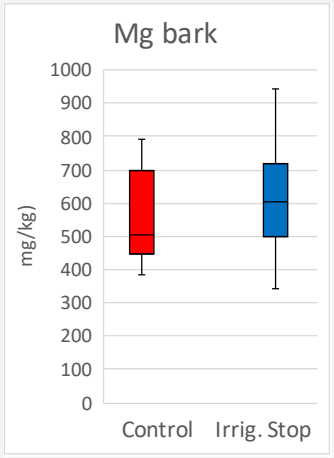
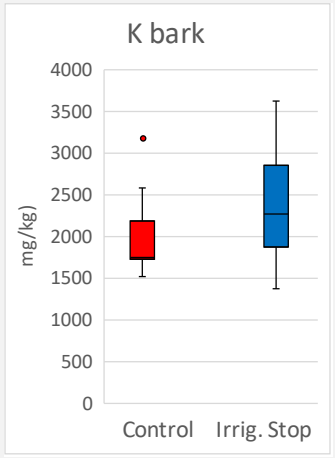
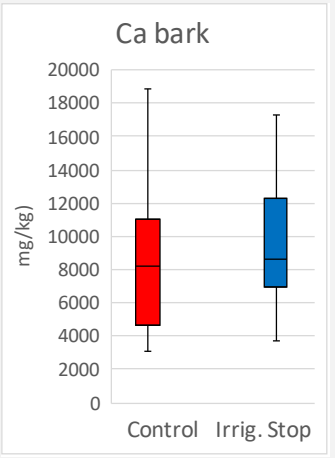
Nutrient concentrations in bark and soil on control and irrigation stop plots at Pfynwald

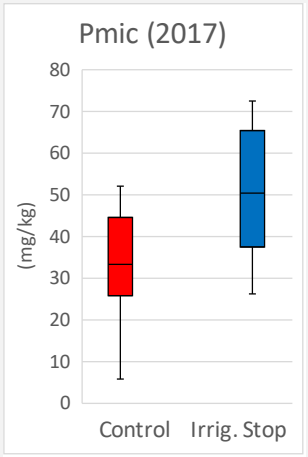


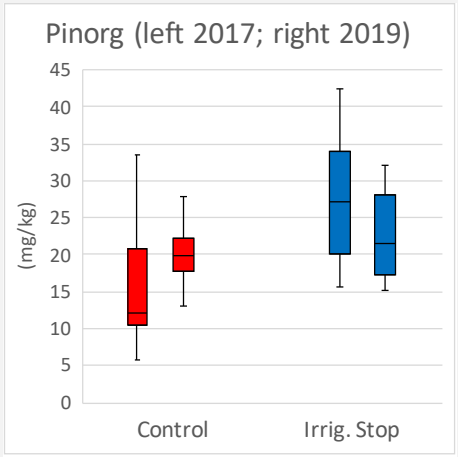


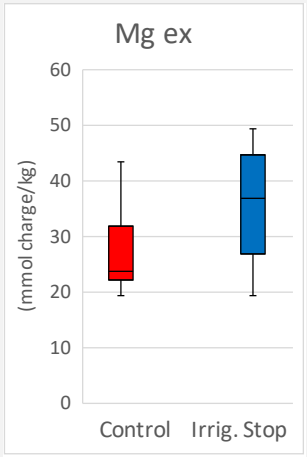


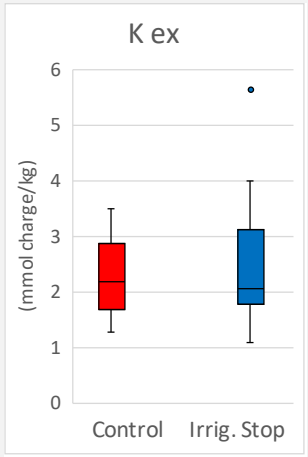


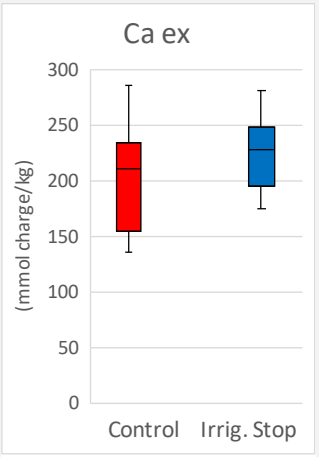












Data from 2019 except where indicated otherwise

Preliminary conclusions

- Operationally bark sampling and analysis works well
- Tree specific concentration ranges in accordance with first results from TU Munich
- N, P, K, and Mg conc. in bark smaller than in foliage; the opposite for Ca
- Relations between nutrient concentrations in bark and soil rather weak except for Mg; there appear to be tree specific patterns
- Relations between nutrient conc. in bark and soil environmental conditions appear to be tree specific