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Agroscope

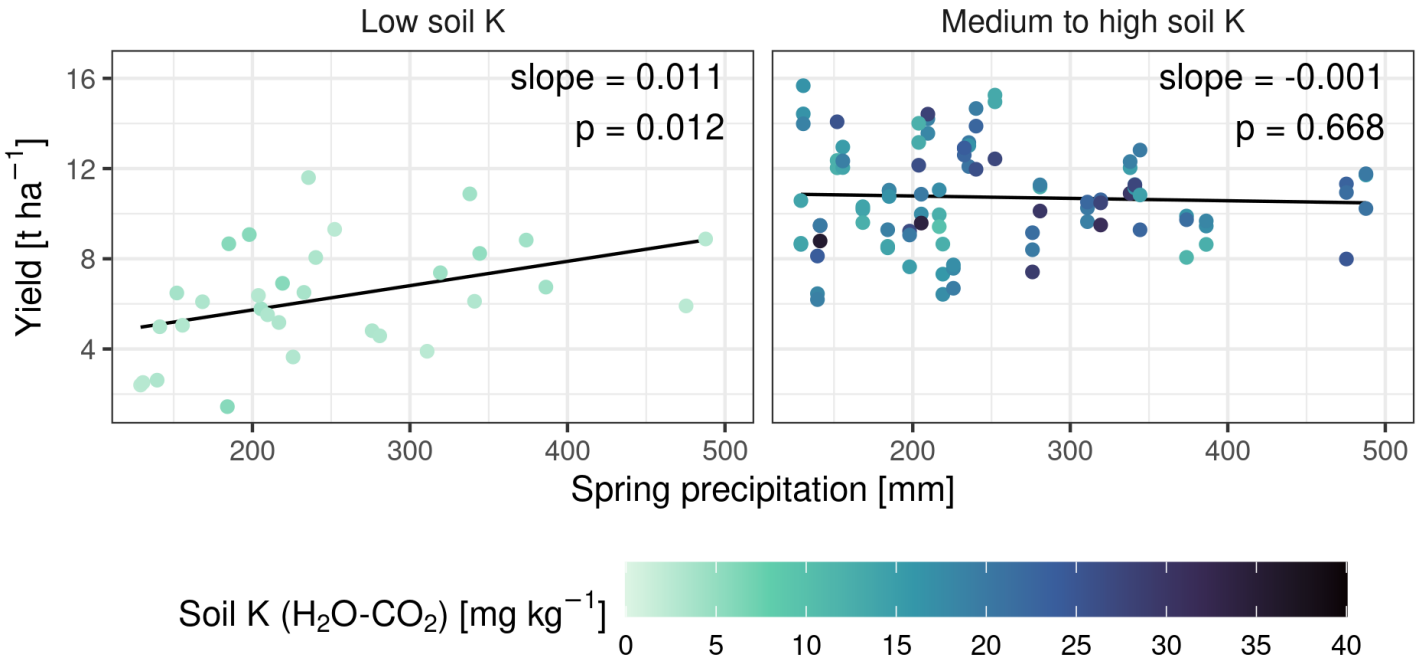
Crop response to soil potassium under diverse pedoclimatic conditions in multiple environments – implications for fertilization recommendations

Juliane Hirte & Frank Liebisch

22 June 2023 | LTE conference Rothamsted

Potassium (K) nutrition and plant water balance

- optimal K supply alleviates water stress of arable crops
- maize yields are reduced by 1 t ha^{-1} for every 100 mm reduction of spring precipitation at low soil K



Frei et al., in preparation

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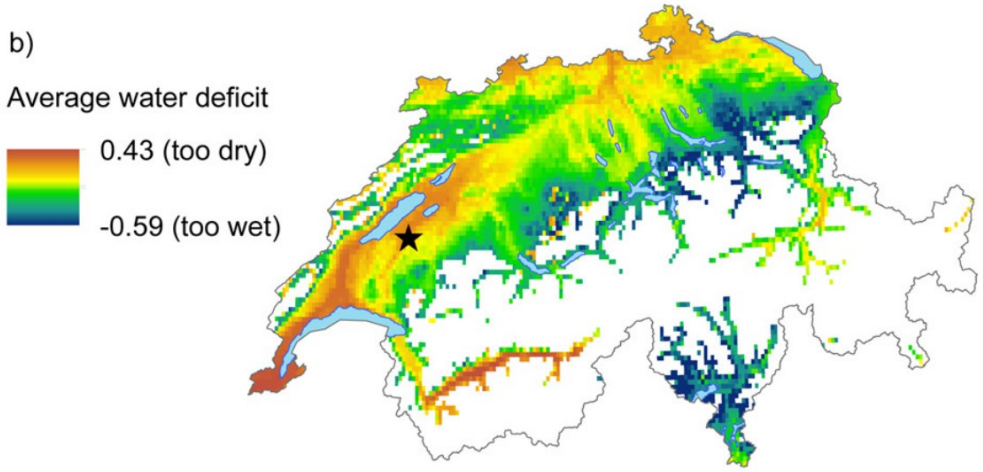
Potassium (K) nutrition and plant water balance

Climate suitability for agriculture:

- annual temperature ↑, heat waves ↑, summer precipitation ↓ Source: MeteoSwiss
- summer crops increasingly suffer from water shortage Henne et al. 2018
- irrigation demands for maize may increase by up to 40% Holzkämper et al. 2020



Holzkämper et al. 2020

Revisiting K fertilization recommendations?

K fertilization recommendations in Switzerland

1. Soil K testing

exchangeable K

HNO_3

Mehlich3

$BaCl_2$

AA-EDTA, AA, AL

Bray

H_2O

H_2O-CO_2

Madaras and Koubova 2015
Zebec et al. 2017
Fontana et al. 2022

2. Yield calibration

yield ~ soil K + soil clay

missing for Switzerland

Acker- und Futterbau					
AAE10-K	Tongehalt der Feinerde (%)				
mg K/kg	< 10	10–19,9	20–29,9	30–39,9	≥ 40
0–19,9	1,5	1,5	1,4	1,4	1,2
20–39,9	1,5	1,4	1,4	1,4	1,2
40–59,9	1,4	1,4	1,3	1,2	1,0
60–79,9	1,4	1,2	1,2	1,2	1,0
80–99,9	1,2	1,2	1,2	1,0	1,0
100–119,9	1,2	1,2	1,0	1,0	1,0
120–139,9	1,2	1,0	1,0	1,0	0,8
140–159,9	1,0	1,0	1,0	1,0	0,8
160–179,9	1,0	1,0	1,0	0,8	0,8
180–199,9	1,0	1,0	0,8	0,8	0,6
200–219,9	1,0	0,8	0,8	0,8	0,6
220–239,9	0,8	0,8	0,8	0,6	0,6
240–259,9	0,8	0,8	0,6	0,6	0,4
260–279,9	0,8	0,6	0,6	0,6	0,4
280–299,9	0,6	0,6	0,6	0,4	0,0
300–319,9	0,6	0,6	0,4	0,4	0,0
320–339,9	0,6	0,4	0,4	0,0	0,0
340–359,9	0,4	0,4	0,0	0,0	0,0
360–379,9	0,4	0,0	0,0	0,0	0,0
380–399,9	0,0	0,0	0,0	0,0	0,0
400–419,9	0,0	0,0	0,0	0,0	0,0
≥ 420	0,0	0,0	0,0	0,0	0,0

3. Soil fertility classification

Principles of crop fertilization in Switzerland (PRIF) 2017: www.prif.ch

Objectives

1. model yield response to soil test K for arable crops in Switzerland
2. evaluate importance of pedoclimatic covariates for yield response models
3. derive critical soil test K values for fertilization recommendations
4. review Swiss fertilization guidelines with respect to changing climatic conditions

STYCS long-term fertilizer experiments

www.langzeit-feldversuche.ch -> STYCS
Hirte et al. 2021

- 6 sites
- 4 replicates
- 6 K fertilization levels (0–167%)

91 site-years

2184 data entries

- yields, available nutrients
- soil and climate variables

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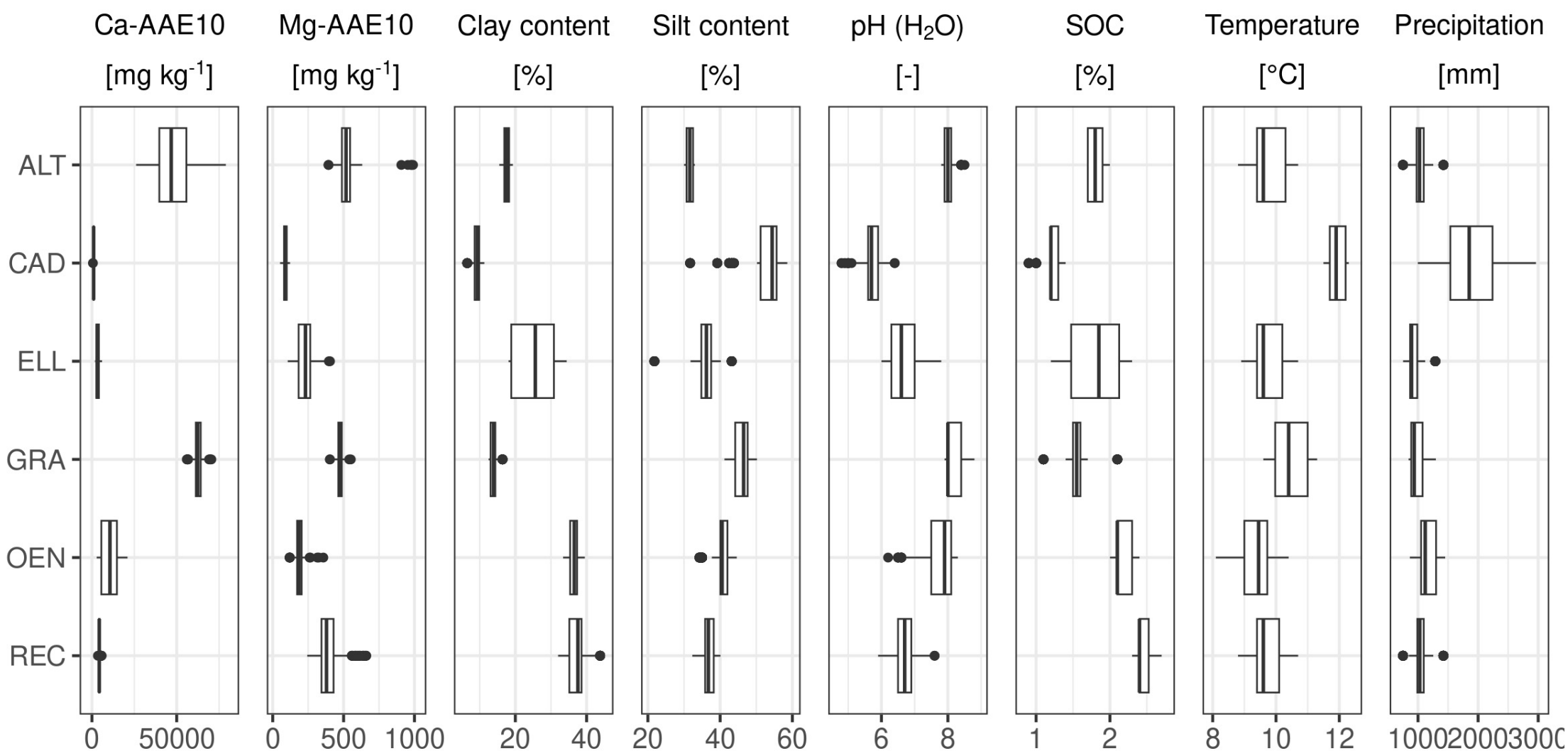
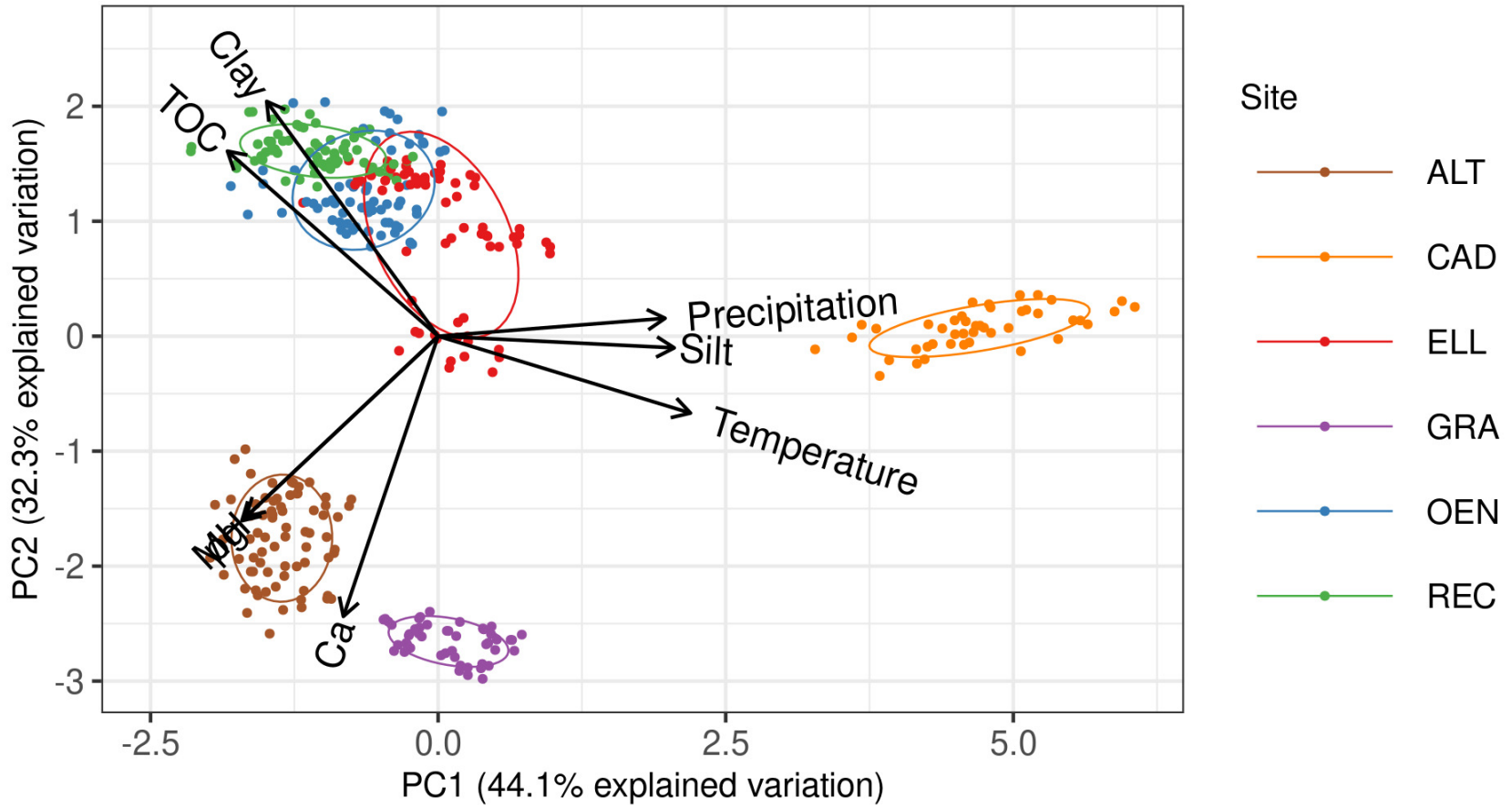
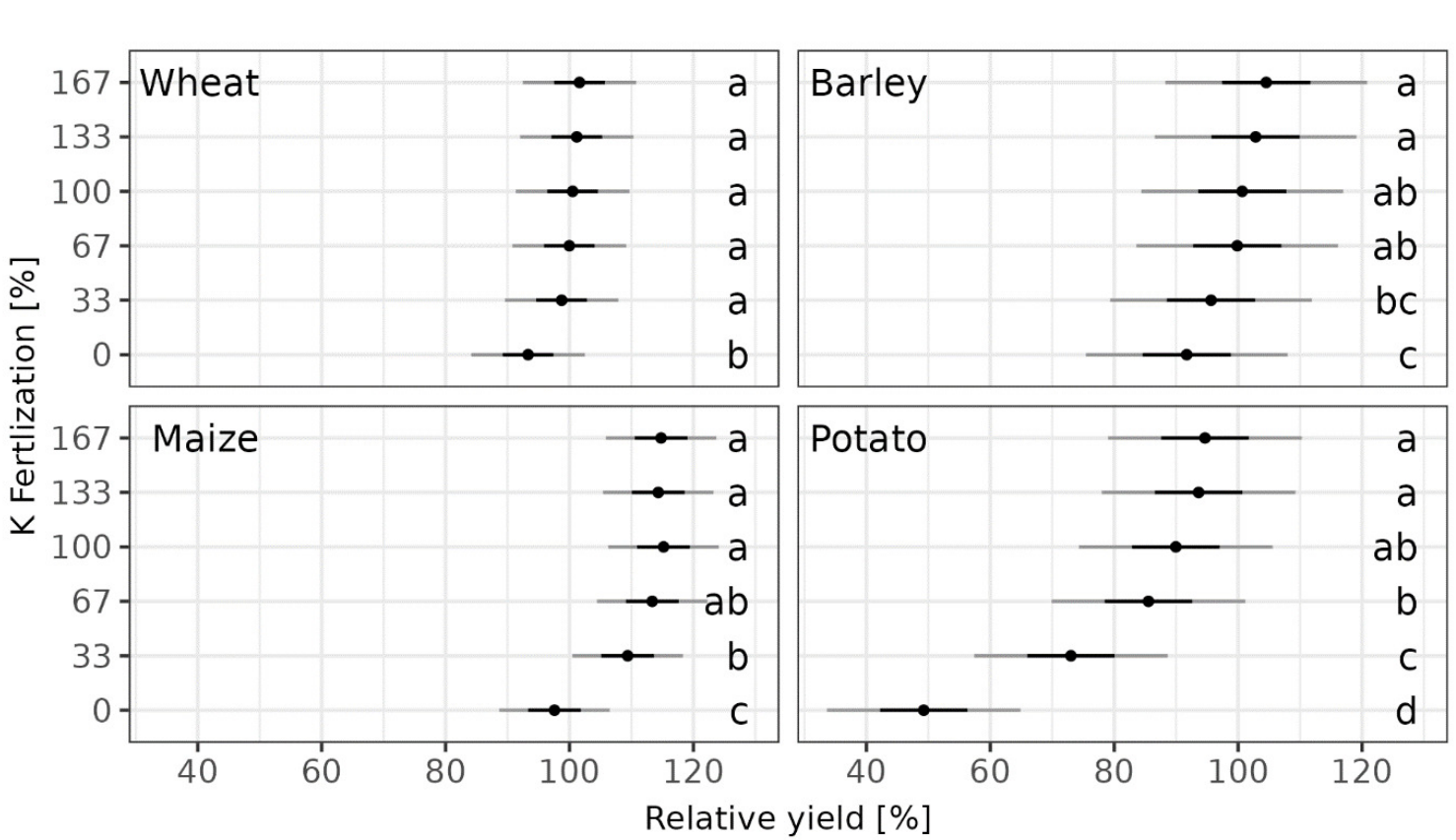
Pedoclimatic conditions

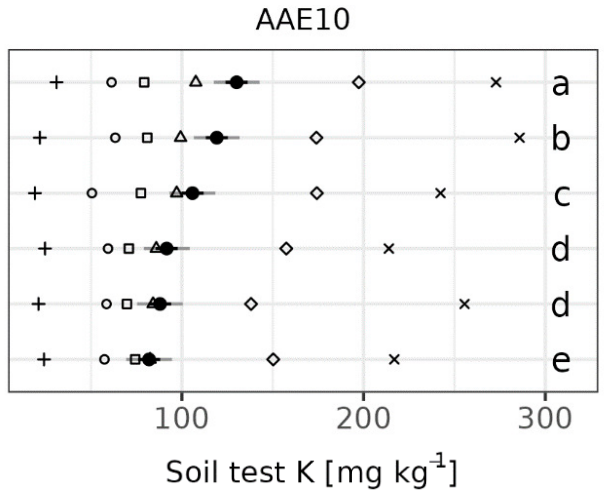


Pedoclimatic conditions

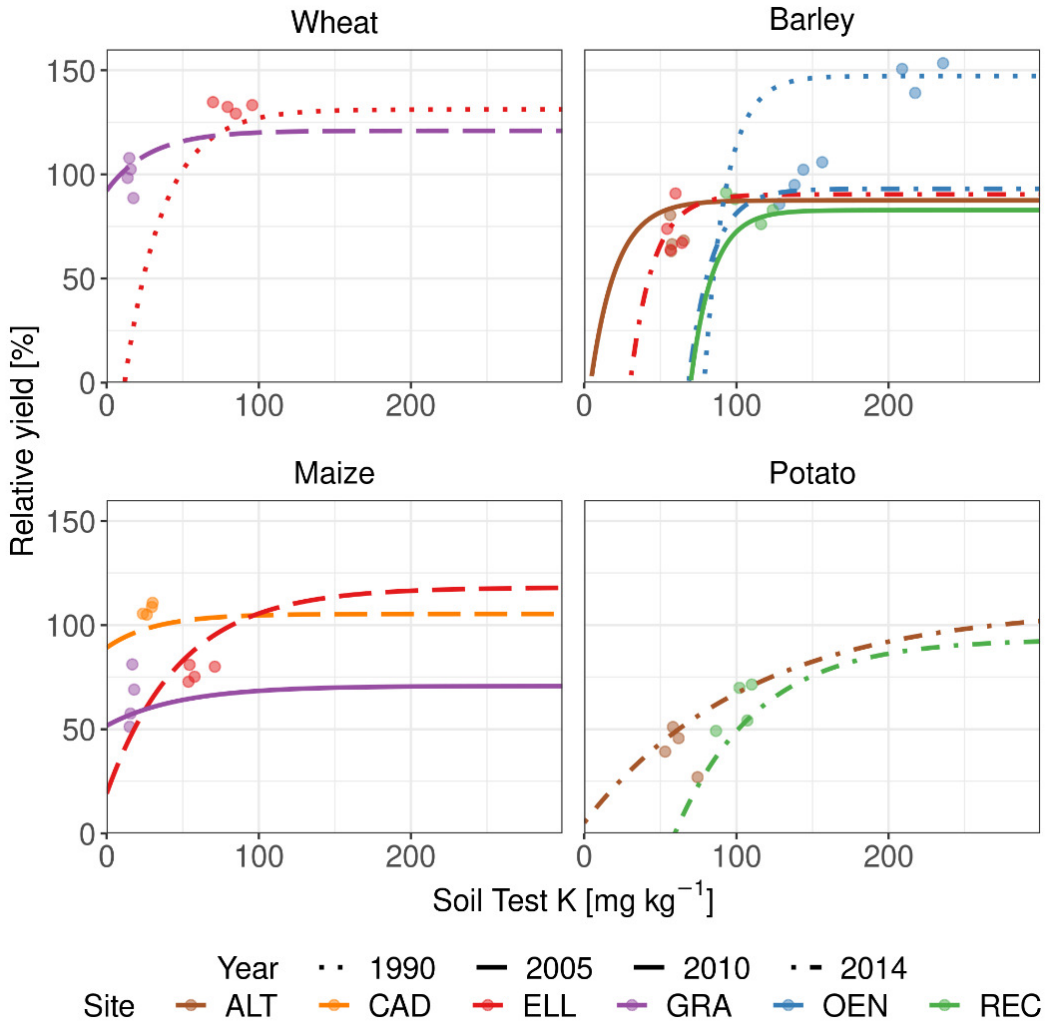


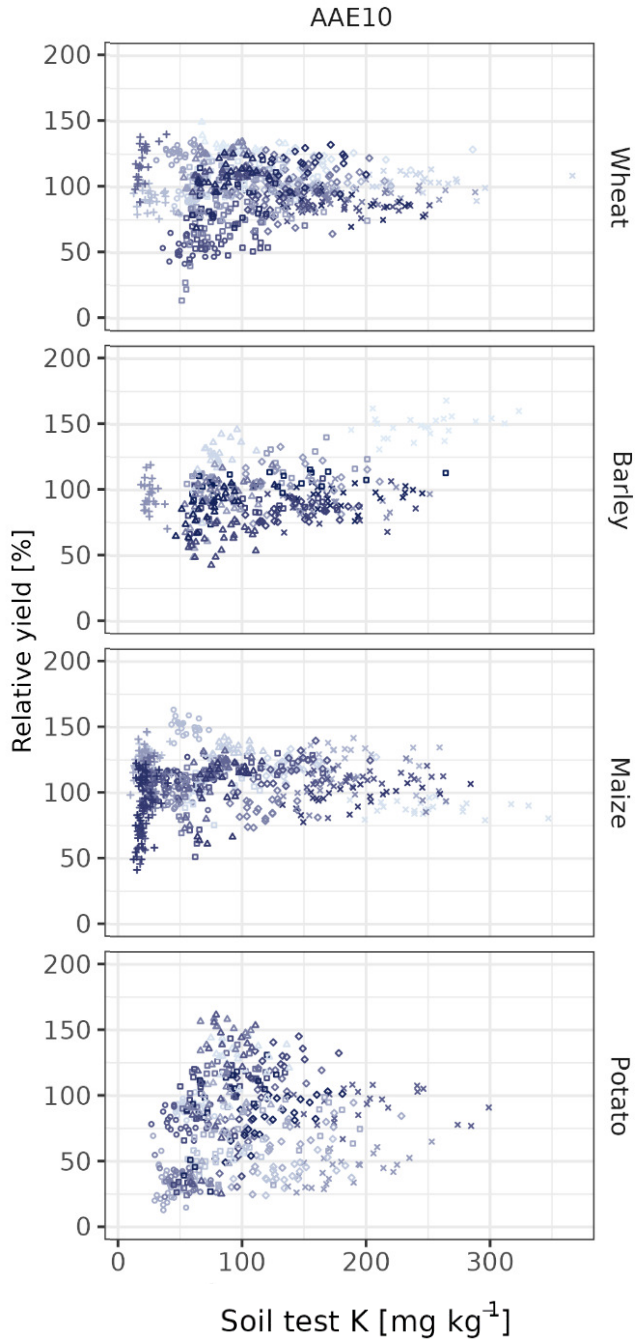
Yields and soil K



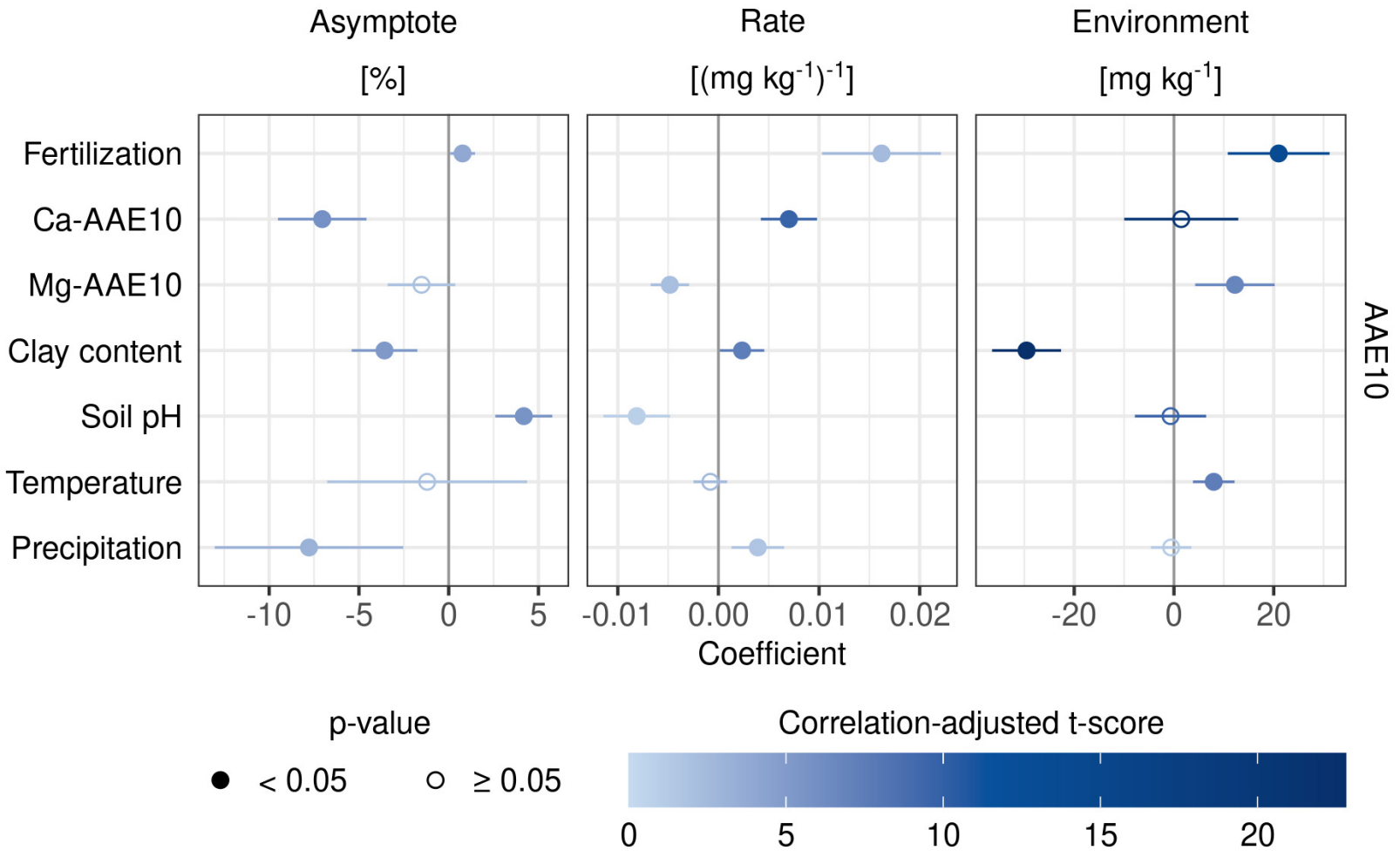


Yield response to soil K – Mitscherlich model



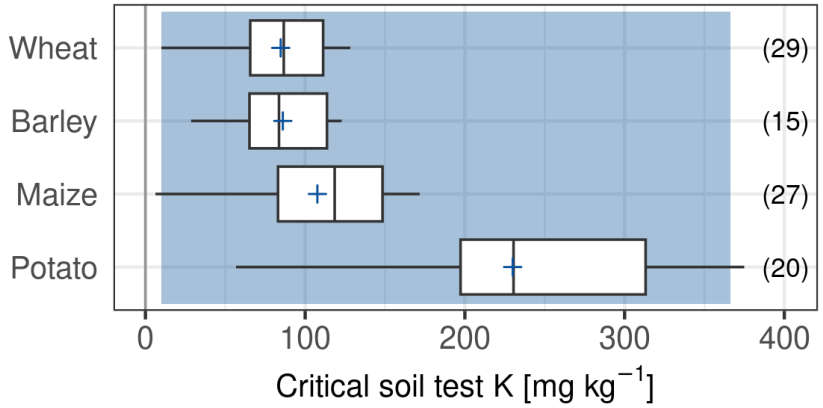


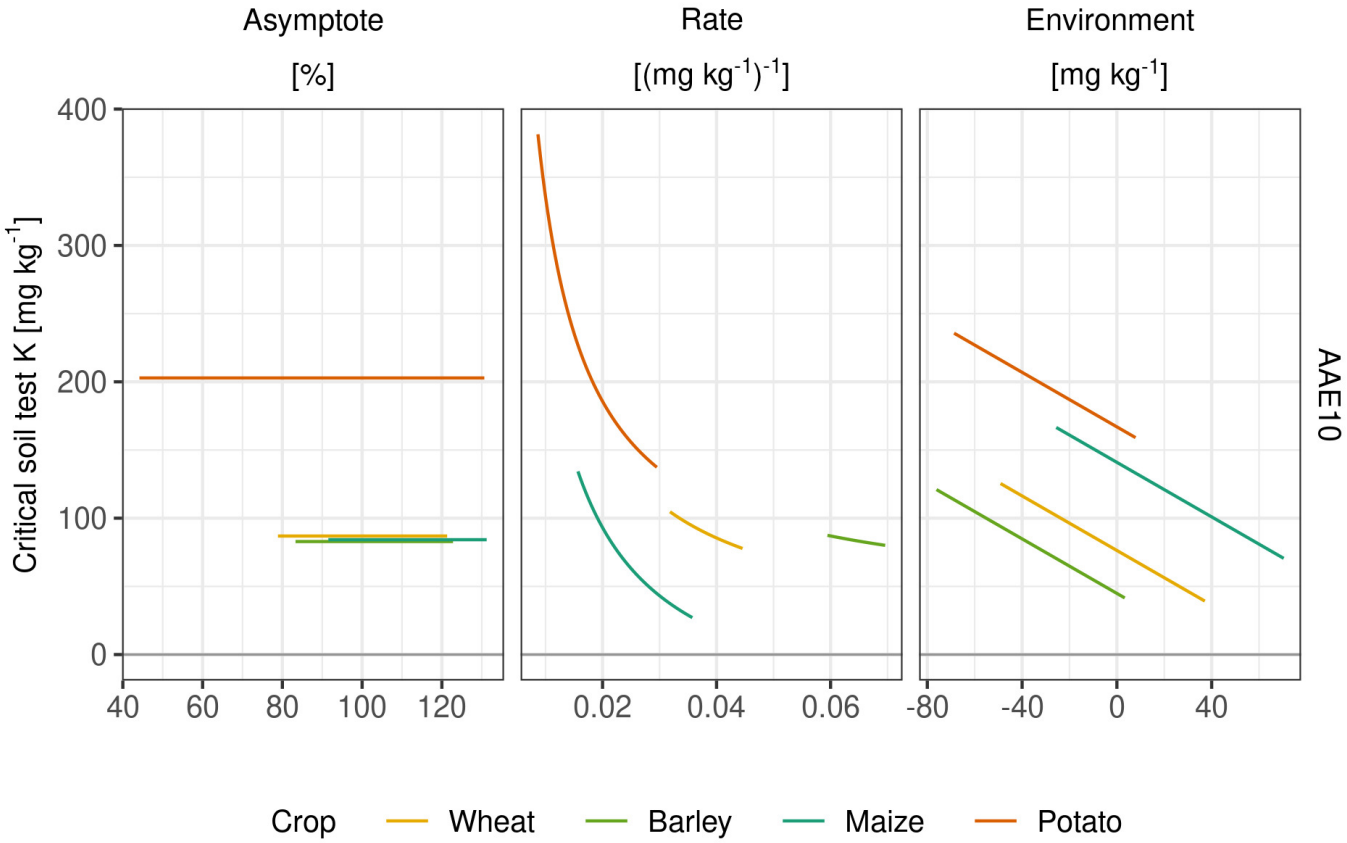
Importance of pedoclimatic covariates



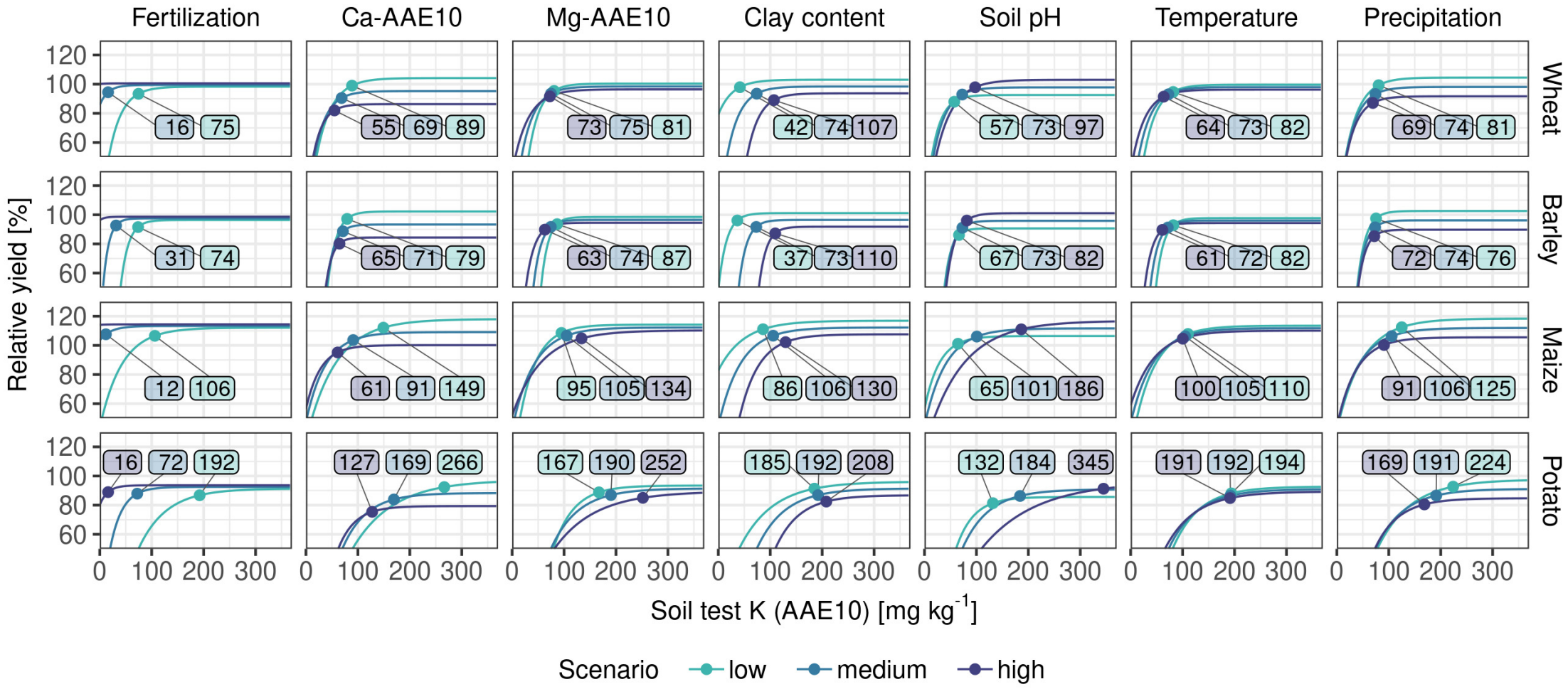
Critical soil test K

- for zero K fertilization
- at 95% maximum yield
- soil test K below which fertilization is recommended





Changing critical soil K with changing covariates



Review Swiss fertilization guidelines

Acker- und Futterbau	Clay content				
AAE10-K					
mg K/kg	< 10	10–19,9	20–29,9	30–39,9	≥ 40
0–19,9	1,5	1,5	1,4	1,4	1,2
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260–279,9	0,8	0,6	0,6	0,6	0,4
280–299,9	0,6	0,6	0,6	0,4	0,0
300–319,9	0,6	0,6	0,4	0,4	0,0

Wheat

Barley

Maize

Potato

Acker- und Futterbau	Clay content				
AAE10-K					
mg K/kg	< 10	10–19,9	20–29,9	30–39,9	≥ 40
0–19,9	1,5	1,5	1,4	1,4	1,2
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280–299,9	0,6	0,6	0,6	0,4	0,0
300–319,9	0,6	0,6	0,4	0,4	0,0

Coming back to be the objectives

1. model yield response to soil test K for arable crops in Switzerland
   -> crop-specific models?

2. evaluate importance of pedoclimatic covariates for yield response models
   -> investigate clay mineralogy and CEC on the 6 sites and / or role of texture as covariate for fertilization recommendations

3. derive critical soil test K values for fertilization recommendations
   -> do critical values at zero fertilization reflect agricultural practice?

4. review Swiss fertilization guidelines with respect to changing climatic conditions
   -> adjustments for summer crops might become necessary in future

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Acknowledgements

Conceptualization, initiation and long-term coordination

René Flisch, Walter Richner

Field and sample management and lab analyses

Hansueli Zbinden, Ernst Brack, Samuele Peduzzi, Katrin Casada, Karin Meier-Zimmermann, civil servants + interns, Diane Bürge, Martin Zuber, Agroscope service lab and many more

Data curation and analysis

Barbara Orth, Serge-Etienne Parent, Manuel Schneider, Jonathan Frei

Funding and support

Agroscope, Jochen Mayer, Shiva Ghiasi, Research group Water Protection and Substance Flows
















Thank you for your attention

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Pedoclimatic conditions