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University of Natural Resources and Life Sciences, Vienna
Department for Sustainable Agriculture Systems
Division of Organic Farming

Soil inorganic N contents and maize yield following winter-hardy vs. freeze-killed cover crop mixtures on an organic farm in Eastern Austria

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Research Question and Objectives

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- Multiple positive effects of cover crops, e.g. on:
  soil protection, soil structure, erosion risk,
  water infiltration, soil organic matter built-up, nitrate leaching,
  biological nitrogen fixation, weed competition, soil biological activity,
  nutrient mobilization, yield of following crops
- What are the *advantages of a winter-hardy vs. a freeze-killed cover crop (CC) mixture* on an organic farm with reduced soil cultivation?
- Test effects on
  (i) **soil inorganic nitrogen** contents after winter
  (ii) **weed density**
  (iii) **yield of a following maize crop**

Material and Methods

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- Two consecutive *field experiments* (FE1 and FE2), randomized complete block design, on an organic farm with mainly non-inverting soil cultivation in Lower Austria
- *Site*: Orthic Luvisol, silty clay - silty loam, pH ≈ 7, 10.5 °C, 760 mm
- *Treatments* (seeding rate, kg ha^{-1})

Winter-hardy CC mixture:
"Landsberger Gemenge", i.e. hairy vetch (102.5), crimson clover (11.3), Italian ryegrass (11.3);

Termination and soil cultivation in April with a rotary cultivator.

Freeze-killed CC mixture:
fodder pea (142.0), common vetch (58.0), chickling vetch (50.0), buckwheat (12.0), phacelia (8.5), fodder radish (8.5);

Soil cultivation in April with a chisel.

Material and Methods

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- *Following crop*: Grain maize, cv “Connexxion”, sown in May, harrowed once, hoed twice
- *Inorganic soil Nitrogen (Nin)* sampling in 0-30, 30-50, 50-90 cm soil depth
- *Weed density* estimated as area-%
- *Maize harvest* on 6 x 1 m^2 per plot
- ANOVA with logarithmic data

Results I – Soil Inorganic Nitrogen

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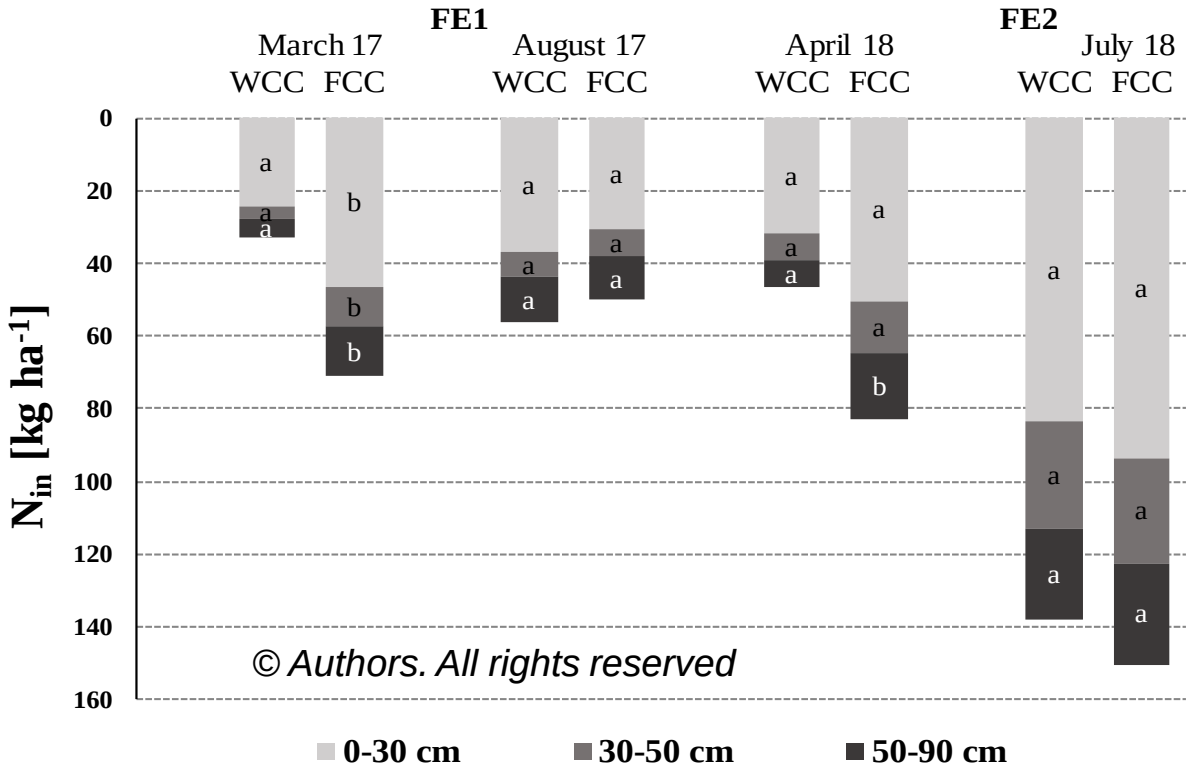
- Soil Nin contents in 0-90 cm depth in spring almost doubled after the freeze-killed CC mixture



WCC: winter-hardy cover crop; FCC: Freeze-killed cover crop. Mean values with same letter at the same date do not differ significantly ($P < 0.05$)

Fig. 1: Soil inorganic N (kg ha^{-1}) in 0-0.9 m after two cover crop mixtures

Results II –
CC biomass and C-to-N ratio, weed density

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- Dry matter biomass: winter-hardy CC in April (2.79 t ha^{-1}) ≈ freeze-killed CC mixture in November (3.10 t ha^{-1})
- Both CC mixtures legume-dominated;
  → Narrow C-to-N ratio (10-13) / high N content of CC residues in both treatments
- Weed density in maize crop moderate until June, high (> 30 %) from June to September in both CC treatments;
  Main weeds: Creeping thistle, chickweed, red dead-nettle, white goosefoot

Results III – Maize yield

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Table 1: Maize grain dry matter yield (Maize DM) and maize N yield (Maize N yield) in both field experiments; Significance of treatment effects (*Trtm*), *Year* and *Trtm*Year*.

Treatment	Experi-ment	Maize DM Mean (t ha^{-1})	± SD	Maize N yield Mean (kg ha^{-1})	± SD
Winter-hardy	FE1	7.29 a	1.26	91.9 a	13.8
CC,	FE2	7.32 α	1.94	100.4 α	26.5
Rotary cultivator	Av.	7.31 A	1.57	96.1 A	18.9
Freeze-killed	FE1	8.33 a	1.63	101.9 a	20.4
CC,	FE2	6.58 α	2.99	92.4 α	49.4
Chisel	Av.	7.46 A	1.52	97.2 A	21.8
Trtm		*0.887*		*0.951*	
Year		*0.420*		*0.975*	
*Trtm*Year*		*0.405*		*0.566*	

FE1: Field experiment 1; FE2: Field experiment 2. SD: Standard deviation. Av.: average; Values with the same (lowercase / Greek / capital) letter in one column are not significantly different ($P < 0.05$).

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- Maize dry matter yield and maize nitrogen yield:
  No sign. difference between treatments

Conclusions

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✓ **Soil inorganic nitrogen content** significantly reduced by the winter-hardy CC mixture.
→ **Reduced nitrate leaching risk**

- Similar **weed density** in both treatments, i.e. combinations of CC mixture and soil cultivation.
  Re-growth of terminated winter-hardy CCs no problem due to intense cultivation with a rotary cultivator.
  High thistle density and competition due to continued non-inversion tillage.
- Similar **maize grain DM yield and maize nitrogen yield** in both treatments.

- Presumably swift N mineralization in both treatments from CC residues with high N content.
  Timing of CC termination obviously less important than **C-to-N ratio of CC residues**.