Grass-clover leys for a sustainable N yield: *Trifolium pratense* cultivar x mixture effects

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Context - improving the composition of seed mixtures for yield

Grass-clover leys allow for an intensive, yet sustainable, forage and livestock production.

- To make recommendations on the choice from among **alternative seed mixtures and mixture components,** it is necessary to make joint comparisons **under target cultivation and management conditions.**

- However, we do not yet know whether **dry matter and N yields of grass-clover mixtures** and **within mixture performance of cultivars** can be predicted based on pure cultivar performance and/or cultivar testing with just any mixture.

Study objectives - testing on mixture, cultivar, and cultivar x mixture effects

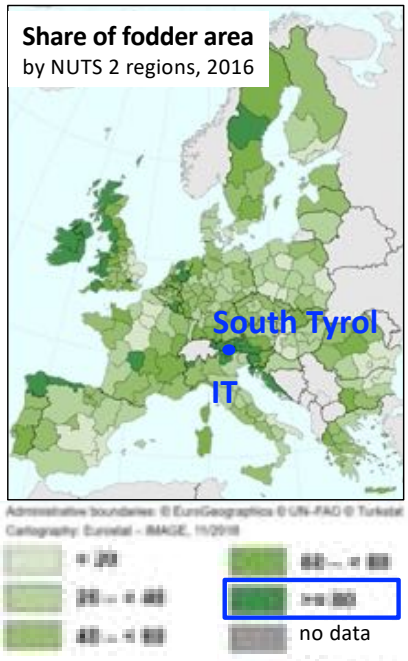
We thus evaluated whether:

- **different cultivars** of late-season yield determining ***Trifolium pratense*** perform differently in terms of **dry matter and N yield and symbiotic N_2 fixation** in different mixture contexts.
- **different grass-clover mixtures for leys** differ in their dry matter and N yield and amount of N derived from the atmosphere (Ndfa).
- *T. pratense* cultivars exhibit **mixture-dependent individual performances and effects on the performance of entire mixtures.**

Study location

Location:
inner-/east-alpine region
Teodone/Dietenheim, South Tyrol, Italy


Mountain region with intensive dairy farming



Elevation:
891 m a.s.l.

Climate: (annual means)
8.4°C, with cold winters
733.5 mm, with dry springs

Soil: (ploughing layer: 0-30 cm)
loamy sand (59.3% sand, 11% clay)
SOC: 2.1%
C/N: 18.3%, pH($CaCl_2$): 5.6

Experimental design - randomized complete blocks

Grass-clover mixture	x	*Trifolium pratense* cultivar
3		**3** = 9 treatments

IR¶ 27.3% *T. pratense* seeds (w)
KG¶ 13.3% ~½
WW§ 5.0% ~½

Milvus (2n, CH) (late autumn growth, persistent)
Semperina (2n, CH) (high yield, long-lived)
Spurt (2n, CZ) (high yield, long-lived)

3 replicates ***=> 27 experimental plots*** (1.2 x 7.4 m),

Regionally recommended ('standard') mixtures in South Tyrol (KG, WW) and Austria (IR):

¶ **for up to 3 years**
§ for up to 4 years for silage or ventilation hay

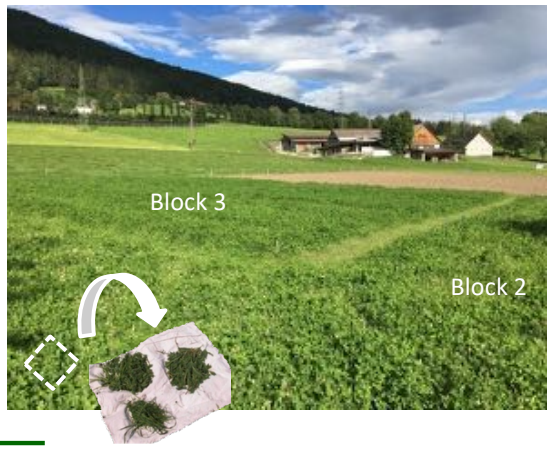
Additional mixture components:
IR: 8.8% *T. repens*
KG: 4.6% *T. repens*, 4.5% *T. hybridum*
WW: 8.0% *T. repens*
+ Grasses: *Dactylis glomerata, Lolium perenne, Phleum pratense, Festuca pratensis, Poa pratensis* (only in WW)

Setup, N fertilisation, and harvesting

1 year

Entire plot:
- DM yield
- N yield

Harvesting mid of August, 3rd of 4 cuts



N- fertilisation:

40 kg mineral N ha^{-1} in spring
15 m^3 ha^{-1} digested cow slurry
after the 1st & 2nd harvest
=> approx. 90 kg N ha^{-1} y^{-1}
=> approx. 120 kg bioavail. N ha^{-1} y^{-1}

0.5 x 0.5 m subplot per plot for:
- **botanical composition**
- plant species-specific [N] & $\delta^{15}N$

Calculations and statistical analyses

Inference of symbiotic N_2 fixation = N derived from the atmosphere (Ndfa):

by natural $\delta^{15}N$ abundance in comparison to the $\delta^{15}N$ signature of the **entire grass fraction** of the specific sward

Carlsson *et al.* 2009, Plant Ecology 205: 87-104.

$$\textbf{pNdfa} = \frac{\delta^{15}N_{Grasses} - \delta^{15}N_{Clover\ species}}{\delta^{15}N_{Grasses} - B}$$

Unkovich *et al.* 2008, ACIAR

B: $\delta^{15}N$ when not fertilised with N,
i.e., grown in N-free growth substrate

Trifolium sp. - specific B values of the shoots of overwintered, re-grown plants before flowering

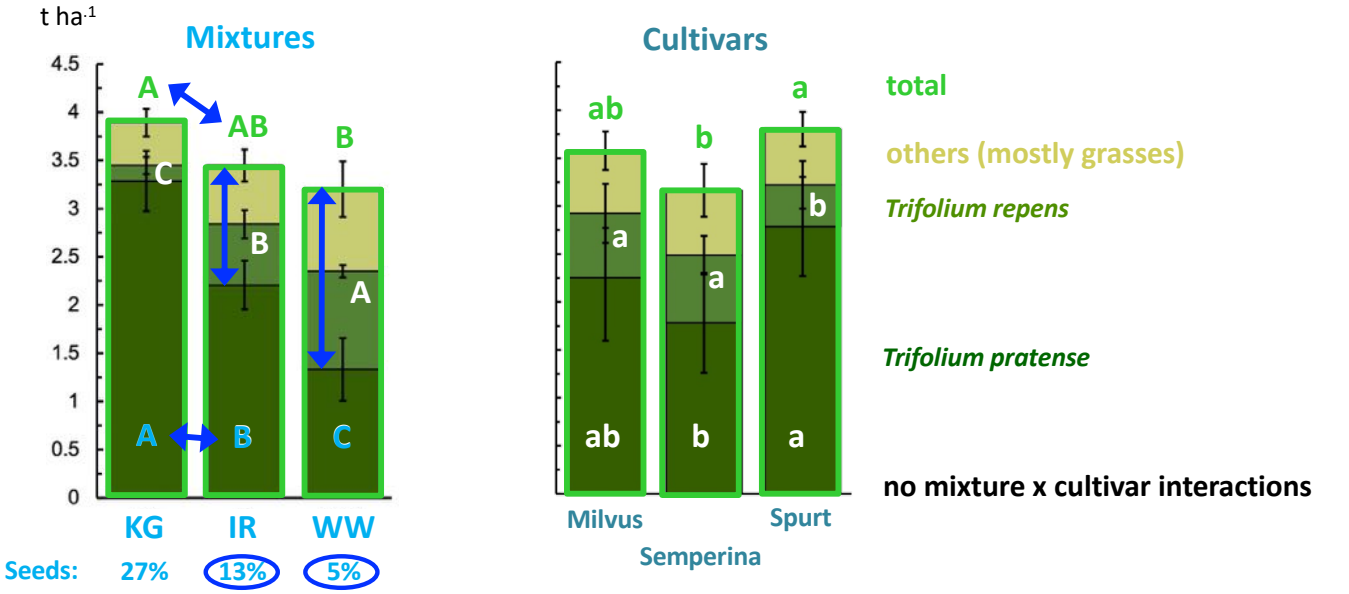
Carlsson *et al.* 2006
Acta Agriculturae Scandinavica, Section B, 56(1): 31-38

N yield = [N] * DM
Ndfa = N yield * pNdfa
Ndfs = N yield - Ndfa

Statistical analysis: ***2-factorial ANOVA***

Dry matter yields

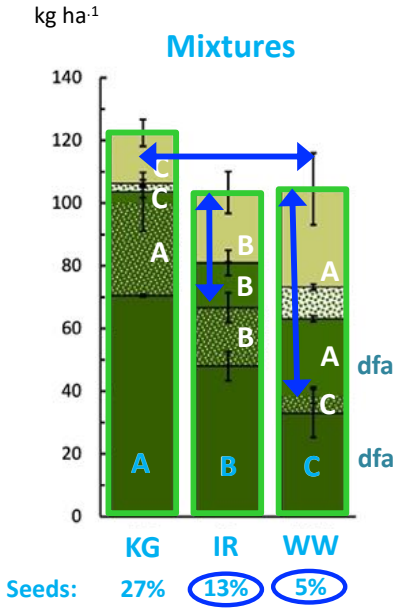
- equal mixture and cultivar effects at the 3rd of 4 cuts in the 1st year

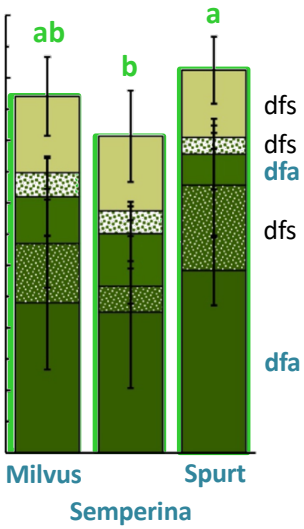


no mixture x cultivar interactions

SEM, LSD, n = 9

N yields from the atmosphere and soil – only cultivar effect





total 56.7 ± 1.1% (n = 27, SEM) via symbiotic N_2 fixation

others (mostly grasses)

Trifolium repens

⅔ via symbiotic N_2 fixation

Trifolium pratense

no mixture x cultivar interactions

dfa: derived from the atmosphere

dfs: derived from the soil

SEM, LSD, n = 9

Conclusions - grass-clover leys provide reliable late summer yields that can be improved through the choice of mixture & cultivar

- **Compensatory growth diminishes the effect of individual mixture components on dry matter and N yield** in species-rich grass-clover leys, stabilising yields.
- Nevertheless, this trial showed that choosing the **grass-clover mixture with the higher *T. pratense* abundance** allowed increasing late summer **dry mater and N yield**, particularly when also the **best performing *T. pratense* cultivar** was chosen.
- It seems that **complete cultivar x mixture trials are not needed** based on this data of the clover-rich late summer cut of the 1st cultivation year.

Study limitations - incomplete information

- data of just the 3rd cut in the 1st year of cultivation (clover-rich harvest -> overestimation of effects by *T. pratense*)
- estimation of symbiotic N_2 fixation by just the natural $\delta^{15}N$ abundance approach and with just reference grasses from within the grass-clover swards (-> underestimation of Ndfa).

… need for analysis of the data of the entire cropping period and further studies at other sites, under different fertilisation, and after liming

p. 397-399

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Thank you for your attention! Any questions?

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