

ROW VS. RELAY INTERCROPPING STRATEGIES OF ORGANIC WHEAT AND CLOVER: OPTIMISING THE TRADEOFF BETWEEN SERVICES.

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In organic stockless systems, nitrogen (N) deficiency and weed infestation are two of the main factors impairing organic wheat grain yield and baking quality [1]. Organic fertilizers and mechanical weeding may improve the performances but are often of limited effectiveness and energy intensive. Forage legumes may be inserted by intercropping to improve the N balance and mitigate weed infestation [2; 3]. The aim of this study is to evaluate how intercropping strategies may impact the trade-off between cash crop production (grain yield and protein content) and ecological services (weed regulation and soil fertility building) provided by forage legume. This study was monitored in organic conditions under temperate climate.

MATERIAL AND METHODS

Study sites

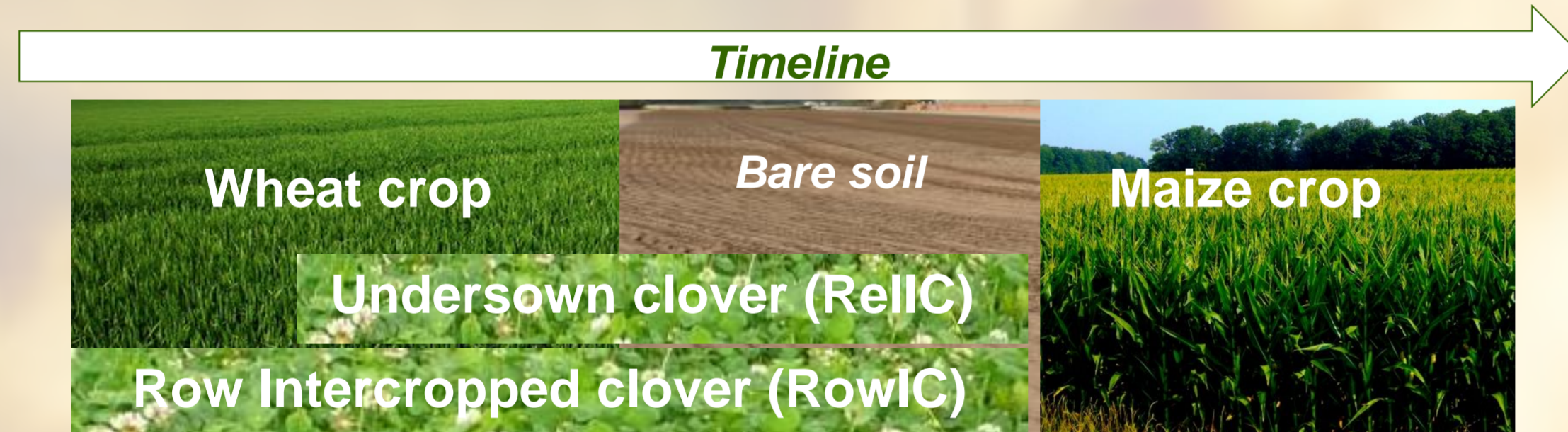
● 3 on-farm experimental fields in south-eastern France in 2014 during two consecutive years:

- Soil textures ranged from sandy soils to clay-loam
- Climate conditions were typical from a temperate climate with mediterranean influence
- Rainfall ranged from 190 to 220mm during intercropping phase for relay intercropped clover and 560 to 780mm during winter wheat growth cycle (and row intercropping phase)

Cropping systems

● 3 studied treatments:

- Sole wheat crop (cv. Renan) sown with a density of 200kg.ha⁻¹ i.e. about 500 seeds.m⁻² as a control treatment (T0)
- Wheat crop intercropped with white clover (*Trifolium repens* cv. Aberdai) cover crops. Two modes of intercropping were tested with a simultaneous sowing of clover with winter wheat (RowIC) or undersown at the end of winter (RelIC) both at a density of 800 plants.m⁻².
- Cover crops were destroyed before the sowing of the next crop (Maize during spring period)



■ 3 complete and randomised blocks in each experimental field.

Monitoring

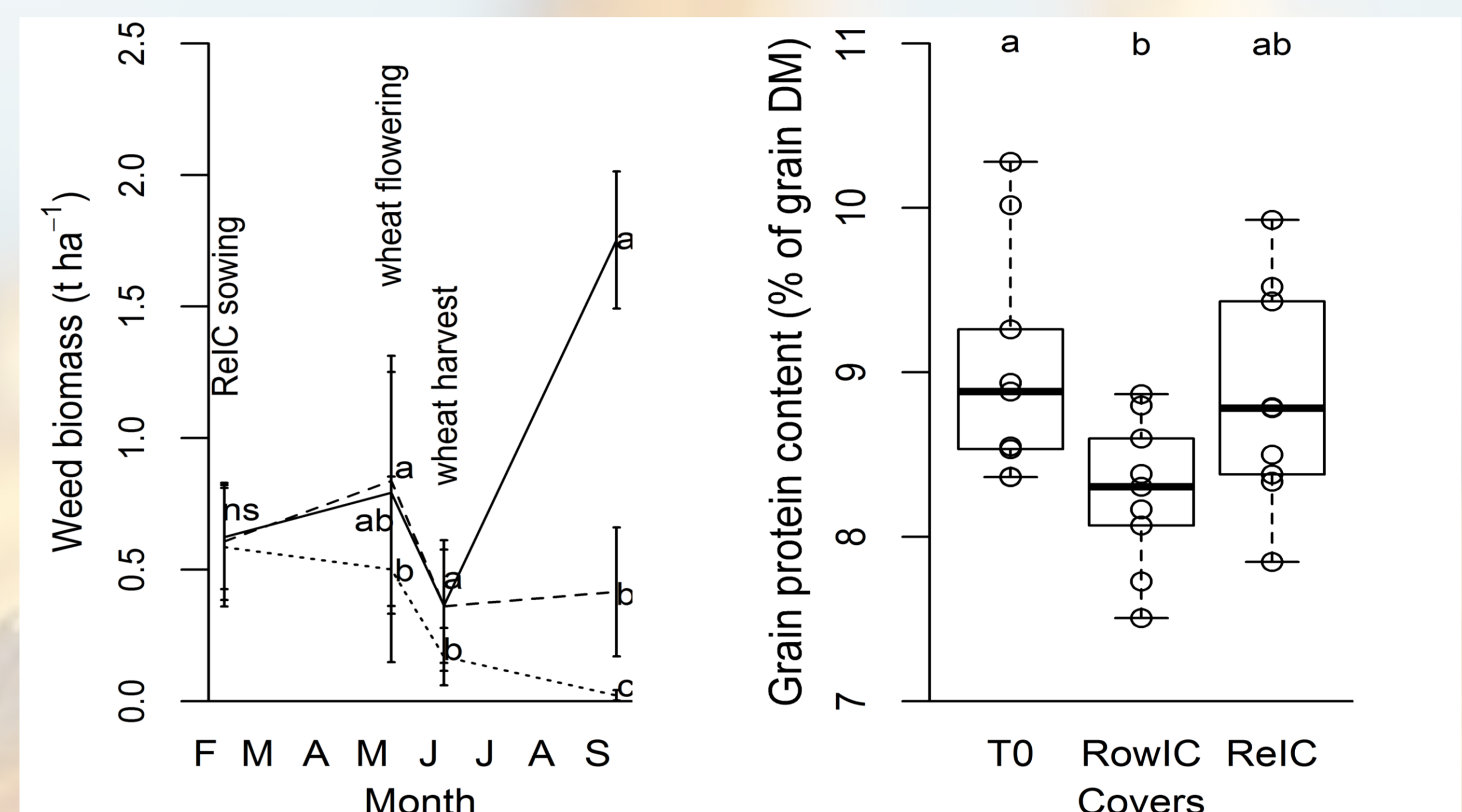
- Wheat crop: biomass and nitrogen content (at crop flowering and harvest) yield components & protein content
- Legumes: biomass and nitrogen (at crop flowering and harvest) and part of nitrogen derived from the atmosphere for nitrogen fixation estimation
- Weeds: Biomass and nitrogen content (at crop flowering and harvest)

RESULTS & DISCUSSION

Row vs. Relay intercropping and legume growth

- Row intercropping guaranteed higher biomass of clover and wheat harvest compared to relay intercropping (respectively 2.2 and 0.1 t.ha⁻¹; p<0.001)
- After wheat harvest, relay intercropped clover grew faster and partly caught up RowIC clover growth before cover destruction (3.6 and 2.4 t.ha⁻¹ respectively; p=0.03)

Figures 1 & 2. Time course of (1) weed biomass and (2) wheat grain protein content according to intercropping strategy. a) (T0: (_); RowIC: (- -) and RelIC: (...)); Vertical lines: confidence intervals (P=0.05; n=9). At each date, intercropping strategy effect was tested by mixed two-way ANOVAs (P=0.05; n=9).



Intercropping strategies and ecological services provided by clover

- Because of low biomass at wheat harvest, RelIC clover did not controlled efficiently weeds during intercropping phase (figure 1)
- After wheat harvest, if RelIC clover fast growth permitted to mitigate weed infestation compared to control treatment (T0), it was still less efficient than RowIC clover (p<0.001; figure 1).
- At wheat harvest, accumulated nitrogen in RowIC clover is significantly higher than in RelIC (respectively 52 and 3kg.ha⁻¹ – p<0.001)
- It was only the consequence of the higher biomass produced as both nitrogen content and nitrogen fixation (Ndfa=83%) were similar.

Relay intercropping limits competition for resources

- Intercropping strategy had no impact on wheat grain yield (ranging from 3.6 to 4.1 t.ha⁻¹ – p=0.21).
- But simultaneous sowing of clover and wheat significantly decreased wheat grain protein content (p<0.001; figure 2), highlighting competition between clover and winter wheat.

CONCLUSION

Simultaneously sowing guarantees sufficient legume biomass during intercropping and maximize ecological services provided by the legume cover crop (i.e. to control weed infestation and accumulate nitrogen for the subsequent crop). However such strategy also increases competition with winter wheat and impairs wheat grain protein content and potentially baking quality. Relay intercropping avoids any competition with wheat [2] but with a reduced accumulation of nitrogen for the next crop and mitigate efficiently weed infestation only after intercropping phase only. This gives elements to think of innovative cropping systems that optimize the tradeoff between services expected from such systems.

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