META-ANALYSIS OF COVER CROPPING SYSTEMS: THE EFFECTS OF COVER CROPS ON SUBSEQUENT CASH CROP YIELDS AND NITROGEN CONTRIBUTION

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INTRODUCTION

Cover crops (CC) in cropping systems

- retain post-harvest nutrients and minimize soil erosion [1]
- can be managed as a source of nitrogen (N) [2]
- may provide non-N rotational benefits [3]
- **Determining the N contribution of CC** would allow
  - Adjustment in the application rate of synthetic N fertilizer
  - Environmental protection and improved profits [4]

Variability in benefits of CC to crop yield : regions / soils / farm practices

Synchrony between crop N demand and CC mineralization is critical [5].

Climatic conditions, **soil properties** and **management practices** act as important **modulators** [6].

OBJECTIVES

To address the variability in CC performance

→meta-analysis of field trials conducted under northern humid temperate climate to quantify

1. the **effect of CC on cash crop yield** (corn, soybean, cereals)
2. the **potential N contribution** of CC, **N accumulated in CC aboveground biomass (N_{CC})**
3. the **effective N contribution** of CC to cash crop yield measured by:
   - **the fertilizer equivalency (FE)** [7]
   - **the inorganic N credit (INC)** [8]

MATERIAL AND METHODS

➢ Meta-analysis of CC effects on cash crop systems based on…

- 28 states/provinces
- 67 published articles + 20 reports
- 211 year*sites (humid temperate climate)
- 2518 CC biomass measurements from CC plots
- 2413 yields measurements from CC plots
- 928 observations from control plots (without CC)

REML approach
Linear mixed-effects model
(SAS Institute, Cary, NC, USA)
- Overall CC effect: univariate
- In cereals: univariate
- In corn : multivariate

➢ What was included?

- CC were grown before an annual cash crop (corn, cereals, soybean) – *Year 1*
- Cash crop yields were reported – *Year 2*
- **CC systems: 3 categories**
  - → **Intercropping** (e.g., red clover into wheat)
  - → **Successive** (e.g., hairy vetch planted after cereal harvest)
  - → **Full season** (e.g., hairy vetch allowed to grow for a full season)
- A control treatment without CC was present
- Treatments were replicated

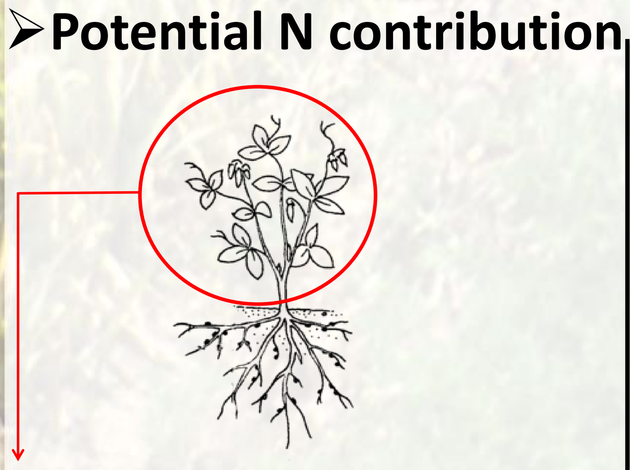
Fig. 1. The map of selected sites

➢ Yield Response

$$\text{YIELD RATIO} = \frac{\text{Cash Crop Yield with Cover Crop}}{\text{Cash Crop Yield without Cover Crop}}$$

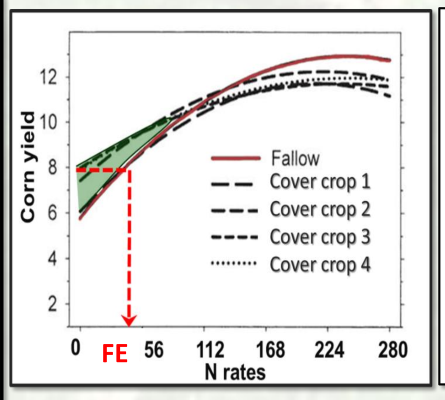
YIELD RATIO = 1 → No effect on yields (*P* > 0.05)
YIELD RATIO > 1 → Positive effects on yields
YIELD RATIO < 1 → Negative effects on yields

➢ Potential N contribution

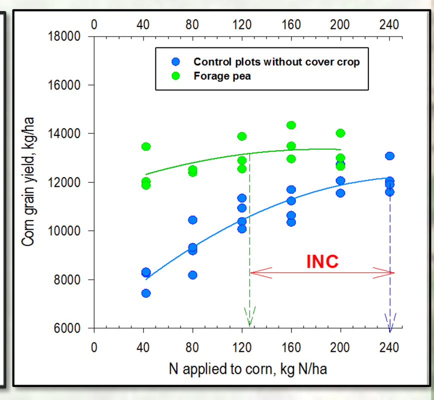


N_{CC} = N concentration x CC biomass

➢ Effective N contribution



FE [7]



INC [8]

RESULTS AND DISCUSSION

I. The effect of CC on cash crop yield

- The overall effect of CC on cash crop yields was significant in corn (+16%) and cereals (+22%).

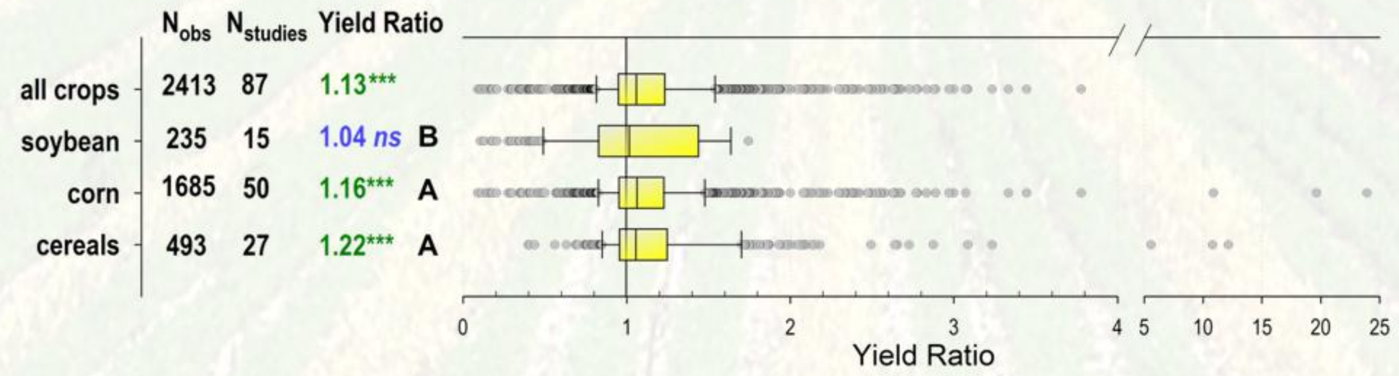


Fig. 2 The overall effect of cover crops on cash crop yields

- Positive impact on yields for CC legumes and mixes with legumes (Fig. 3).
- Grasses: overall negative impact on corn but not on cereal yields
- Non-legume broadleaves: positive impact on cereal but not on corn yields

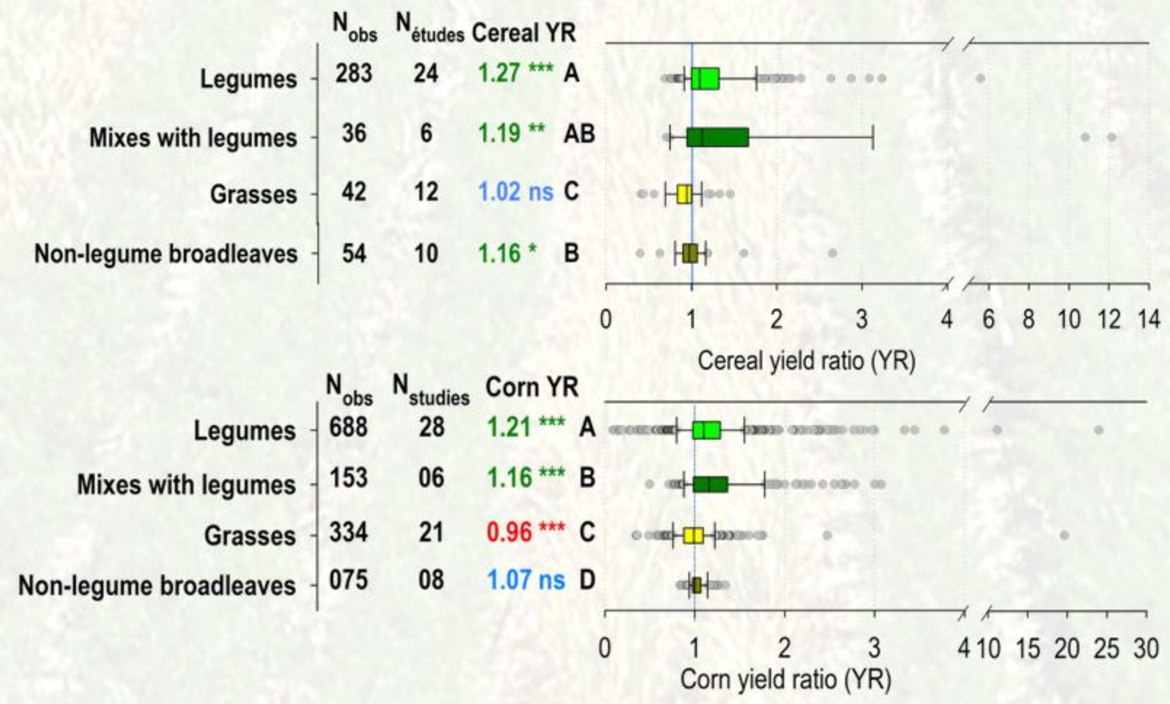


Fig. 3 The effect of CC types in corn and cereal production

II. Modulation of the CC effect on corn yield

II-1. Impact of corn fertilization

- Corn fertilizer N influenced CC effects on corn yield but this influence varied depending on CC types (Fig. 4).

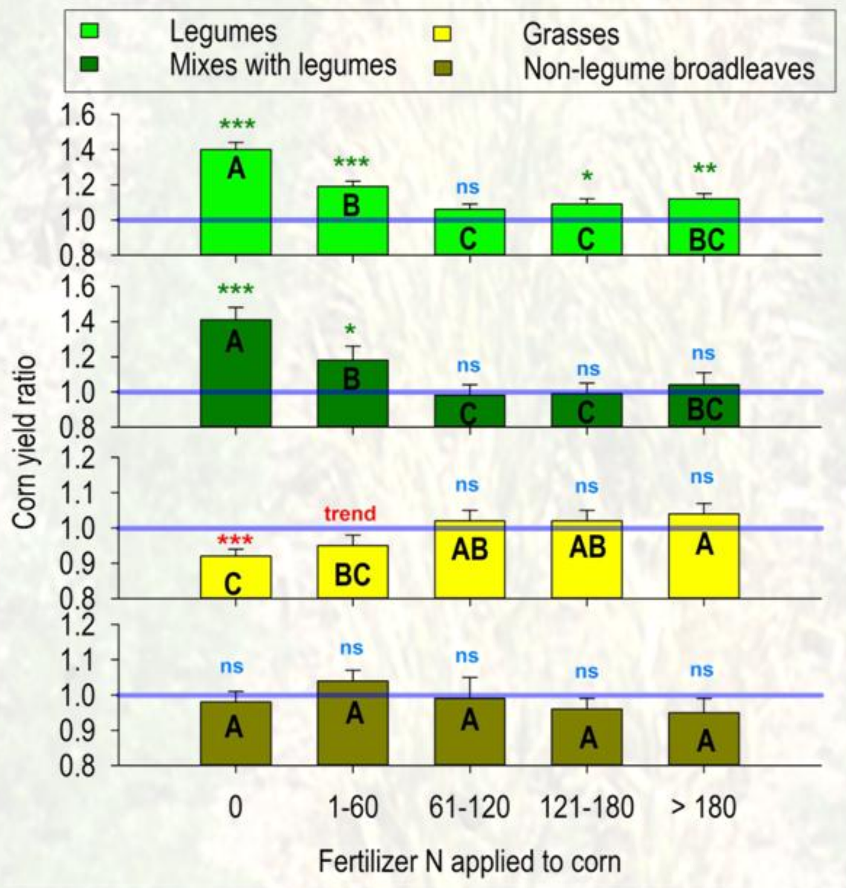


Fig. 4 Modulation of the CC type effect on YR by N fertilization

II-2. Impact of soil organic matter (SOM)

- Gain in corn yield ↘ as corn N fertilization ↗ but…
- ↗ 9% in corn yield at 120 kg N/ha in low-SOM content soils(<2%)
- ↗ 10% in corn yield at 60 kg N/ha in medium-SOM content soils (2-5%)

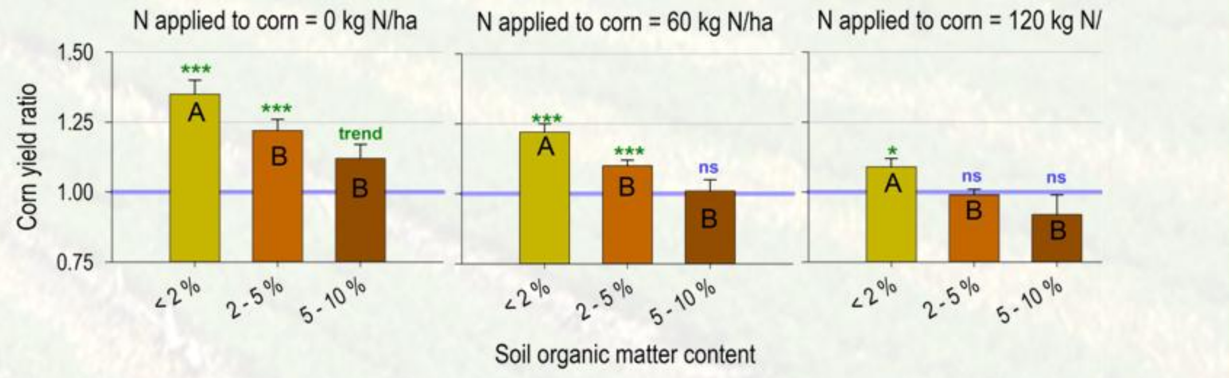


Fig. 5 Modulation of the fertilization effect on YR by SOM content

II-3. Impact of precipitations (AWDR)

- CC effects on corn yield were modulated by the AWDR [9] (Fig. 6).

CC Legumes: best benefits to corn regardless of AWDR, >20% of yield ↗

CC grasses : 6 to 13-% ↘ in corn yield in drier and medium conditions corn yield losses compensated in wet conditions

AWDR: Abundant and well-distributed rainfall [9]

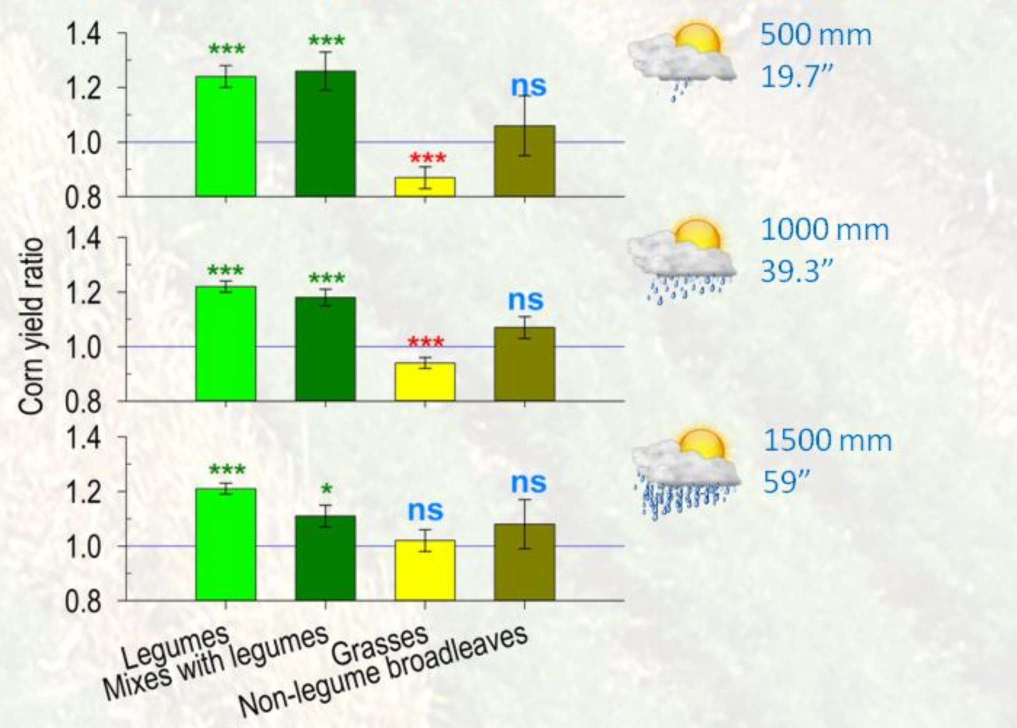
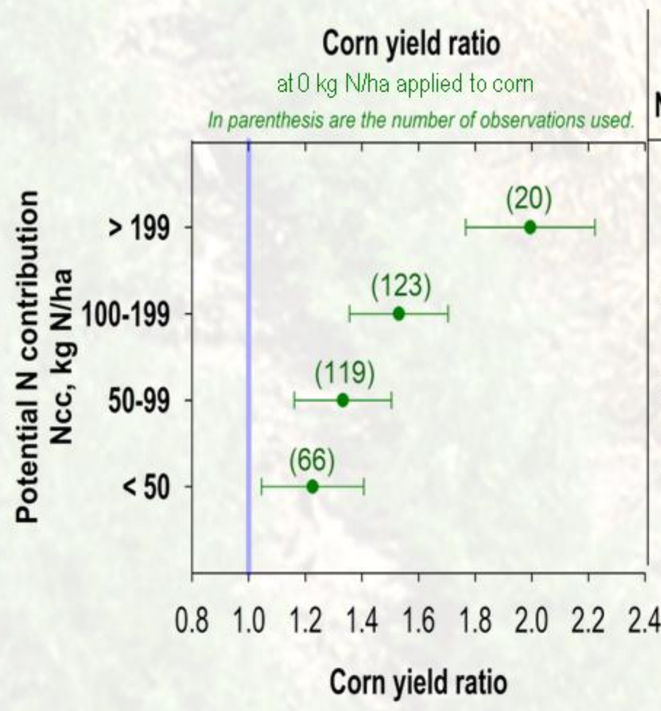


Fig. 6 Modulation of the CC type effect on YR by precipitation

III. N contribution of legume CC to corn yield

Overall estimate: legume FE = 86 kg N/ha. Mixes with legumes = 57 kg N/ha.

- Legume FE ↗ as Ncc ↗ with higher corn YR (Fig. 7) .
- Legume INC was less influenced by Ncc (Fig. 7)



Potential N contribution Ncc, kg N/ha	N_{obs}	$N_{studies}$	FE	(CI 95%)	N_{obs}	$N_{studies}$	INC	(CI 95%)
> 199	4	3	111	(65 - 157) ***	6	4	81	(27 - 134) **
100-199	39	8	91	(68 - 113) ***	38	7	122	(94 - 149) ***
50-99	34	8	71	(48 - 94) ***	15	7	100	(64 - 136) ***
< 50	17	6	51	(24 - 79) ***	9	2	84	(27 - 140) **

Fig. 7 Potential vs. effective contribution of legume CC to corn yield

CONCLUSIONS

- **N contribution of legume CC and mixes with legumes: 86 and 57 kg N/ha on average**
- **Benefits of legume CC and mixes with legumes to cereal and corn yields: range of 16 % to 27%.**
- **Grass CC slightly decreased corn yields but corn yield losses were compensated around 60-120 kg N/ha and in wetter years.**
- **CC benefits were still noticed at 60 and 120 kg applied N/ha in soils with lower organic matter content (< 2%).**
- **CC types and the Ncc significantly impacted FE.**

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