Results Fact Sheet(s):

Comparing long-term vs. first-time vs. no cover cropping to understand grain corn yields and nitrogen uptake

Research team: Dr. Laura Van Eerd, Yajun Peng

OBJECTIVE

Understand the nitrogen contribution of cover cropping duration on corn grain yield and nitrogen uptake using 15N tracer technique.

STUDY DESIGN

We established LTCC, FTCC, and NOCC treatments in the permanent LTCC experiment, at Ridgetown, ON. We planted CC in main NOCC plots as FTCC treatment. The plot size of FTCC was 3 m (4 corn rows) by 4 m long. After CC emergence, ammonium nitrate (11 lbs/ac of N) tracer fertilizer (15N-enriched) was applied to CC and followed into CC, corn, and soil to 90 cm depth.

OBSERVATIONS

- Long-term cover cropping impact is likely a best-case situation in terms of CC growth (long growing season with CHU 3600 at Ridgetown), and high frequency of cover crops grown (11 times in 15 years) in this processing vegetable-grain crop system.
- No nitrogen fertilizer was applied to grain corn to study the effect of CC-derived nitrogen to grain corn.
- Weather in 2022: total precipitation between September and November was only 35% of 30 years of mean values (2022 vs. 30-year average: 75.9 vs. 214 mm).

KEY RESULTS

- During the cover crop (CC) season (August to April), long-term cover cropping (LTCC) and first-time cover cropping (FTCC) retained 2 times more of the 11 lbs/ac of fall-applied fertilizer nitrogen (N) than no cover cropping (NOCC) (i.e., 50% less N losses with cover crops).
- By corn harvest, only 5% of the previous fall-applied fertilizer N was taken up by the corn crop and it didn't matter if a cover crop was grown or not.
- By corn harvest, 52 to 67% of the previous season's fall-applied N applied to FTCC and LTCC, respectively, were found in soil, mainly in soil organic matter.
- With no fertilizer N applied to the corn crops, LTCC had 27.4 bu/ac (24%) greater. and more consistent corn grain yield than NOCC, while FTCC was intermediate (Figure 1).

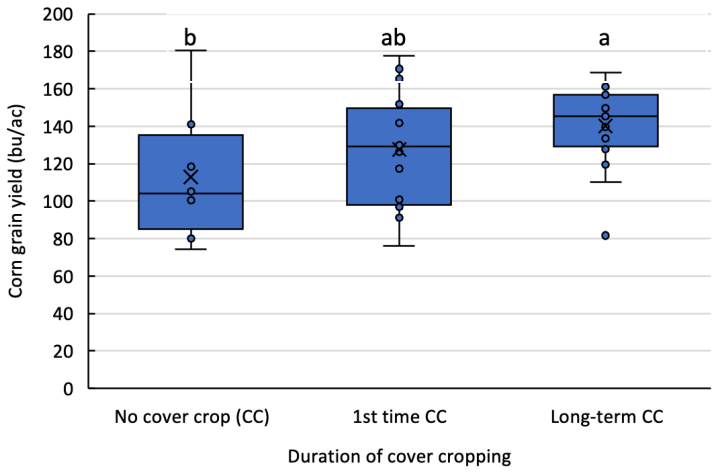

Figure 1. Corn grain yield response to the duration of annual cover cropping from two site-years at Ridgetown ON. Corn was grown **without** fertilizer N in 2022 and 2023. Annual cover crops were grown 11 times in 15 years in the long-term treatment. Different letters indicate differences among treatments (p= 0.0045, n= 16 but no cover control n=8). Cover crops tested were oat, winter cereal rye, radish, and mix of radish+rye.

RECOMMENDATIONS

- Using cover crops (even once) reduces overwinter nitrogen losses from the field by 130%.
- LTCC improves nitrogen uptake by subsequent crops by enhancing nitrogen retention over the winter and by accumulations in soil organic matter (up to 0.5% greater).

STUDY PARAMETERS

TREATMENTS: LTCC, FTCC, and NOCC

EXPERIMENTAL DESIGN: RCBD (4 reps)

PLOT SIZE: Main CC plot: 16 m x 6 m. 15N microplots: 1.5 m x 1.1 m

SITE YEARS: Site A: 2021-2022; site B: 2022-2023

FIELD LOCATIONS: Van Eerd's two long-term cover crop experiment sites at Ridgetown (Site A: established in 2007; Site B: repeated in 2008).

SOIL TYPE: Sandy loam (Orthic Humic Gleysol), with 77%-17%-6% of sand-silt-clay; soil organic matter: 3.4 to 3.9% depending on cover crop; Sites A and B: soil had 6.7 to 6.9 pH (1:2 saturated paste), 19 to 26 mg P kg^{-1} (Olson sodium bicarbonate extraction method), 156 to 185 mg of K kg^{-1}, 152 to 154 mg of Mg kg^{-1}, 1,171 to 1, 242 mg of Ca kg^{-1} (ammonium acetate extraction method), and CEC of 8.8 to 9.1 meq 100 g^{-1} (calculated based on soil test values of cations).

PLANTING DATES: Cover crops were planted in late August 2021/2022, while corn crops were planted in early May 2022/2023.

HARVEST DATES: Cover crops were terminated in mid April 2022/2023, while corn crops were harvested in late October 2022/2023.

PREVIOUS CROPS (PAST TO PRESENT): Grain corn, soybean, winter wheat (CC), fresh pea (CC), sweet corn, winter wheat (straw removal; CC), tomato (CC), grain corn, acorn squash (CC).

VARIETIES: Corn hybrid was P0157AM (Optimum® AcreMax®) in 2022, while it was P306 in 2023.

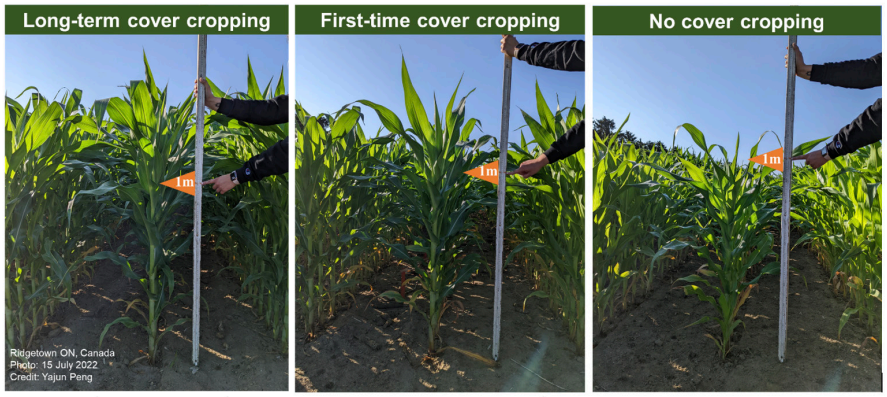

Figure 2 Comparison of corn height under long-term vs. first-time vs. no cover cropping

PLANT POPULATION: Separate cover crop treatments tested were oat (*Avena sativa* L.), winter cereal rye (rye; *Secale cereale* L.), radish (*Raphanus sativus var. longipinnatus* L.), and a mixture of radish and rye (radish/rye) planted at 81, 67, 16, and 9/34 kg/ha, respectively. Corn hybrid P0157AM in 2022 (Site A) and corn hybrid P0306 in 2023 (Site B) were each planted at 34,000 seeds/ac.

ROW SPACING: 30" for corn, 7.5" for cover crops

TILLAGE: Prior to planting CC, main crop (acorn squash) residues were incorporated using a high-speed disc followed by cultivation. After CC planting, there was no soil disturbance except with the corn planter.

MANAGEMENT: Cover crops grown with 11 lbs/ac of N tracer fertilizer (15N-enriched), 90 lbs/ac of phosphorus (P), and 82 lbs/ac of potassium (K) broadcast incorporated prior to planting in late August. The following spring, cover crops were terminated with Factor® (a.i. 540 g glyphosate L^{-1}) at a rate of 1.5 L/ac. No N fertilizer was applied to corn. About 1.96 L/acAcuron® (a.i. 7.1 g bicyclopyrone L^{-1}, 28.5 g mesotrione L^{-1}, 120 g atrazine L-1, and 257 g S-metolachlor L^{-1}) and 1 L/ac Factor® (a.i. 540 g glyphosate L^{-1}) were sprayed for weed control after one or two weeks of corn planting.

CREDITS

Project contact: Dr. Laura Van Eerd, University of Guelph Ridgetown Campus, lvaneerd@uoguelph.ca

Project code: C2022AG07

Photos courtesy of: Yajun Peng

This research was supported by Grain Farmers of Ontario.

Funding was provided by the Fresh Vegetable Growers of Ontario and the Ontario Agri-Food Innovation Alliance, a collaboration between the government of Ontario and the University of Guelph.

Additional resources:

- The problem solvers: Yajun Peng by Ontario Grain Farmer, Treena Hein https://ontariograinfarmer.ca/2024/06/01/the-problem-solvers-yajun-peng/
- Peng, Y., Rieke, E. L., Chahal, I., Norris, C. E., Janovicek, K., Mitchell, J. P., ... & Van Eerd, L. L. (2023). Maximizing soil organic carbon stocks under cover cropping: insights from long-term agricultural experiments in North America. Agriculture, Ecosystems & Environment, 356, 108599. https://doi.org/10.1016/j.agee.2023.108599
- Peng, Y., & Van Eerd, L. L. (2024). Surface soil sampling underestimates soil carbon and nitrogen storage of long-term cover cropping. Geoderma Regional, 39, e00885. https://doi.org/10.1016/j.geodrs.2024.e00885