PRACTICAL FARMERS OF IOWA
COOPERATORS' PROGRAM Farmer-Led Research

EXPERIMENT

2021

Effect of Planting Green on Corn Seedling Disease, Stalk Rot and Yield – Year 2

Staff Contact
Stefan Gailans - (515) 232-5661
stefan@practicalfarmers.org

In a Nutshell:

- Jack Boyer, Eric Fynaardt, Kevin Holl and Rob Stout conducted strip trials for a second year to test the effect of cereal rye cover crop termination date on corn disease pressure and corn yield. They each compared terminating the cover crop before planting corn to terminating the cover crop after planting corn.

Key Findings:

- Across the four farms, cover crop termination dates ranged from 6 to 14 days before planting corn (before-plant) to 4 to 8 days after planting corn (plant-green).
- At only one farm (Fynaardt's) did we observe a negative effect on corn yield from planting green.
- Dr. Alison Robertson's lab team from ISU Plant Pathology and Microbiology observed no effects of cover crop termination date on corn stands, number of barren plants and stalk rot at any of the farms. At Fynaardt's only, they detected reduced seedling shoot and root weights in the plant-green treatment.
- After two years of study, yield drag occurred in only two of seven instances – both occurred at Fynaardt's and translated to a 5–6% reduction in yield compared to terminating the cover crop at least 6 days before planting corn.

Cooperators

Jack Boyer – Reinbeck
Eric Fynaardt – Searsboro
Kevin Holl – Conrad
Rob Stout – Washington

Collaborator

Dr. Alison Robertson,
ISU Plant Pathology & Microbiology

Funding

USDA-NIFA

BACKGROUND

Most recommendations suggest terminating a cover crop at least 10 days before planting corn to avoid early-season deficiencies of soil moisture and soil N. On-farm strip trials by PFI cooperators between 2016 and 2018 backed up those recommendations. In those trials, cooperators reported significant corn yield reductions (2 to 14%) when cover crops were terminated within two days of planting corn.[1–3] Recent scientific evidence points to corn seedling disease as the culprit for yield dag when planting corn soon before or soon after terminating a cover crop.[4] Contrary to these research findings, some farmers report no problems when planting corn before terminating a cover crop. (Otherwise known as planting green.) In these cases, the cover crops were typically only a few inches tall at the time of corn planting. Many farmers experienced with using cover crops stress the importance of applying N fertilizer with the corn planter for alleviating the potential for yield drag when planting green. The appeal to planting green is that the practice allows the cover crop to grow longer into the spring and thus enhancing the soil and water conservation benefits a cover crop provides.

In 2020, Jack Boyer, Eric Fynaardt, Kevin Holl and Rob Stout conducted the first iteration of this project with only Fynaardt observing reduced yields from planting green.[5] They each repeated the trial in 2021 in order to further explore their interests (as well as many other farmers' interests) in planting corn to a green cover crop.

Strips at Jack Boyer's on May 4, 2021. At left, a plant-green treatment strip; the cover crop was eventually terminated on May 7 (8 days after planting corn). At right, a before-plant treatment strip where the cover crop was terminated on Apr. 23 (6 days before planting corn).

METHODS

Design

Each cooperator seeded a cereal rye cover crop shortly after soybean harvest in Fall 2020. Boyer, drilled at 65 lb/ac on Nov. 4; Fynaardt, airseeder + Phoenix till lite at 56 lb/ac on Nov. 11; Holl, drilled at 90 lb/ac on Nov. 17; Stout, drilled at 56 lb/ac on Oct. 6. Each cooperator planted corn in 2021 and field management at all farms is provided in **Table 1**.

TABLE 1. Corn management among farms in 2021.

	BOYER	FYNAARDT	HOLL	STOUT
Fertilizer, Fall 2020	Nov. 15, 2020: 90 lb K/ac as potash	Nov. 16, 2020: 150 lb N/ac as anhydrous ammonia	Nov. 15, 2020: 8 lb N/ac, 39 lb P/ac as MAP; 60 lb K/ac as potash	Nov. 25: 2020: 109 lb N/ac as swine manure
Fertilizer, pre-plant	Apr. 1: 100 lb N/ac as anhydrous ammonia	None	None	None
Corn planting	Apr. 29: 30-in. rows; 35,000 seeds/ac	Apr. 30: 30-in. rows; 34,500 seeds/ac	Apr. 29: 30-in. rows; 35,000 seeds/ac	Apr. 29: 30-in. rows; 36,000 seeds/ac
N fertilizer, at-plant	Apr. 29: 30 lb N/ac as UAN(32)	Apr. 30: 30 lb N/ac as UAN(32) and ATS	Apr. 29: 35 lb N/ac as UAN(32)	Apr. 29: 39 lb N/ac
N fertilizer, Sidedress	June 2: 20 lb N/ac as UAN(32)	None	June 12: 140 lb N/ac	June 2: 100 lb N/ac as urea
Corn harvest	Oct. 21	Nov. 13	Nov. 18	--

To test the effect of cover crop termination date on corn, each cooperator compared two treatments:

1. Before-plant. Target: terminate cover crop ~18 days before planting corn
2. Plant-green. Target: terminate cover crop ~6 days after planting corn.

Actual cover crop termination dates at each farm is provided in **Table 2**.

TABLE 2. Cover crop termination dates among farms in 2021.

		BOYER	FYNAARDT	HOLL	STOUT
Before-plant	Date	Apr. 23: Mad Dog (40 oz/ac): Actamaster (2 lb/ac)	Apr. 24: Roundup (32 oz/ac)	Apr. 15: Glyphosate (40 oz/ac)	Apr. 15: Roundup (32 oz/ac)
	DBP	6	6	14	14
Plant-green	Date	May 7: Mad Dog (40 oz/ac): Actamaster (2 lb/ac)	May 5: Roundup (32 oz/ac); Volley ATZ (1.8 qt/ac); MesoCore (10 oz/ac); Lambda-Cy (3.2 oz/ac)	May 5: Glyphosate (40 oz/ac)	May 3: Tripleflex (2 pt/ac); Atrazine (1.5 lb/ac); Roundup Powermax (26 oz/ac); UAN(32) (34 lb N/ac)
	DAP	8	5	6	4

DBP = days before planting corn.
DAP = days after planting corn.

Each cooperator implemented at least four replications of the two treatments in randomized strips (**Figure A1**). Strips at each farm were as wide as at least one combine pass and ran the length of the field.

Measurements

Cooperators measured cover crop height and groundcover at both termination dates. To determine groundcover, cooperators took photographs from three to four locations in each strip and then we analyzed them using Foliage, an open-source web-based application.[6]

Dr. Alison Robertson's lab group travelled to Boyer's, Fynaardt's, and Holl's farms on June 2 and to Stout's farm on June 4 to determine corn stand densities, corn seedling shoot weights and corn seedling root weights. The lab group assessed barren plants and stalk rot incidence at Boyer's, Fynaardt's, and Holl's on Sept. 16 and at Stout's on Sept. 24.

All cooperators harvested corn from each individual strip, except for Stout because a high-wind incident in August made it impossible to detect individual cornrows and strips. Grain yields from Boyer's, Fynaardt's and Holl's were corrected to 15.5% moisture.

Data analysis

To evaluate any effects of cover crop termination date, we calculated the least significant difference (LSD) at the 95% confidence level using a t-test for each measurement: cover crop height, cover crop groundcover, corn yield, corn stand density, corn seedling shoot weight, corn seedling root weight, barren plants and stalk rot. For each measurement, if the numeric difference resulting from the two termination dates was greater than the LSD, we would expect such a difference to occur 95 times out of 100 under the same conditions – we refer to this as a statistically significant effect. On the other hand, if the numeric difference resulting from the two termination dates was less than the LSD, we considered the results statistically similar. We could make these statistical calculations because the cooperators' experimental designs involved replication of the two cover crop termination dates (**Figure A1**).

RESULTS AND DISCUSSION

Cover crop height and groundcover

At Boyer's, Holl's and Fynaardt's, terminating the cover crop after corn planting (plant-green) resulted in a cover crop that was roughly twice as tall as the cover crop terminated before corn planting (**Figure 1A**). At Stout's, the later terminated cover crop was three times as tall as the cover crop terminated before corn planting. At all sites but Stout's, the cover crop in the plant-green treatment provided 60% more groundcover on average than the cover crop terminated before corn planting (**Figure 1B**). We did not see this same response at Stout's despite the cover crop in the plant-green treatment being three times as tall. This was probably because the cover crop in the plant-green treatment was terminated (May 3) four days prior to when he took photos to assess groundcover (May 7). The Foliage web application measures groundcover by detecting greenness from photographs. When Stout took photos on May 7, the cover crop in the plant-green treatment had already begun to senesce (brown) and this may have resulted in the Foliage application detecting less groundcover than was actually present. In general, and not surprisingly, the cooperators observed far more cover crop growth in the plant-green treatment as judged by height and groundcover. This was because the cooperators terminated the cover crop in the plant-green treatment, on average, 16 days after they terminated in the before-plant treatment.

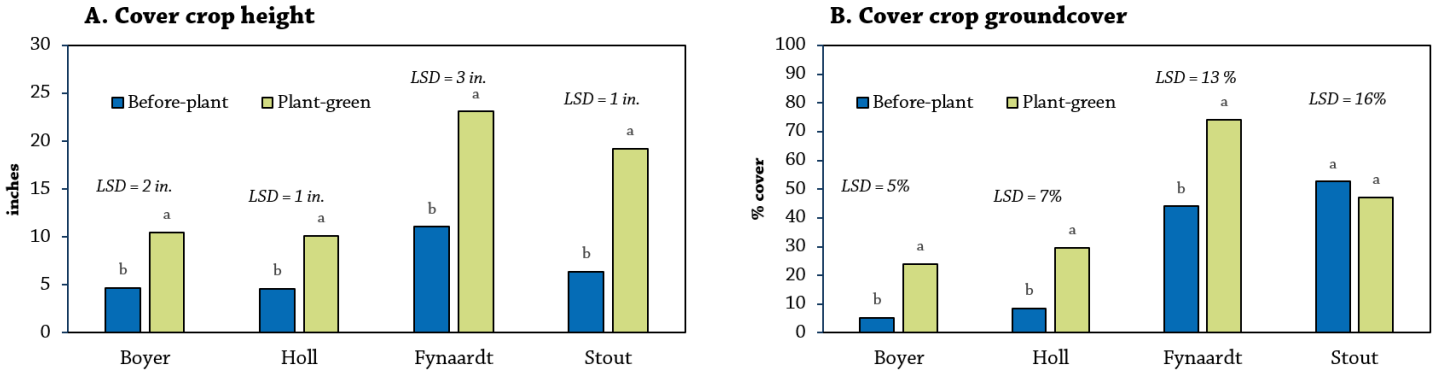
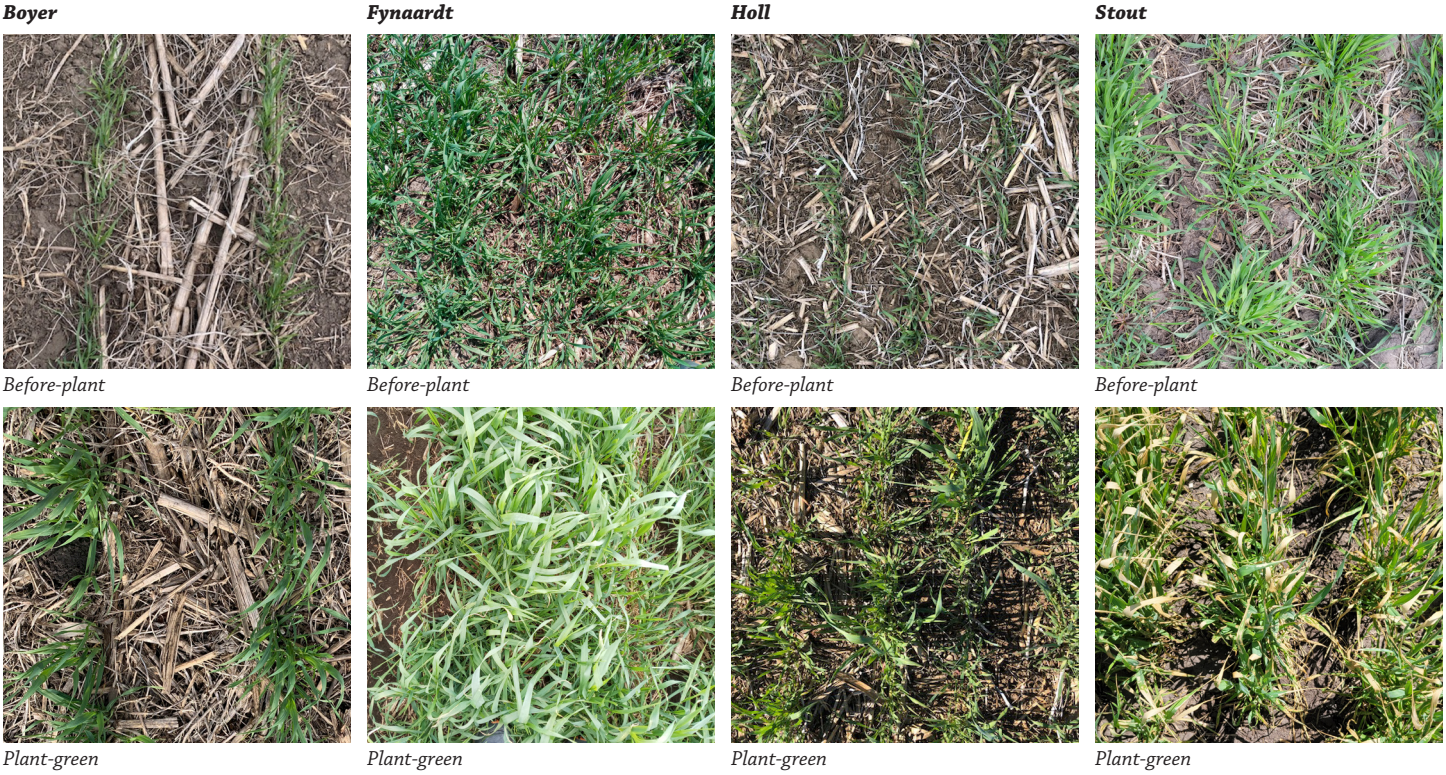


FIGURE 1. Cover crop height (A) and groundcover (B) as affected by cover crop termination date at each farm in 2021. By farm, letters above columns indicate whether differences were greater than the least significant difference (LSD) at the 95% confidence level. Number of days between termination dates, by farm: Boyer, 14 days; Fynaardt, 11 days; Holl, 20 days; Stout, 18 days.



From left to right, photos from Boyer's, Fynaardt's, Holl's and Stout's of cover crops from the before-plant (top) and plant-green (bottom) treatments used to assess groundcover. Note the browning of the cover crop from termination four days prior in the plant-green treatment at Stout's (far right, bottom photo).

Corn yield

Neither Boyer nor Holl observed differences in corn yield between the before-plant and plant-green treatments on their farms (**Figure 2**). Average yields on their farms were 240 bu/ac at Boyer's and 262 bu/ac at Holl's. Fynaardt, however, saw a 13 bu/ac reduction from the plant-green treatment (201 bu/ac vs. 214 bu/ac in before-plant treatment). All three farmers applied N fertilizer at planting (**Table 1**), which many farmers claim can reduce the potential for yield drag when planting corn green. It could be that Fynaardt suffered yield drag in the plant-green treatment because he planted into more than twice as much cover crop as Boyer and Holl did. At Fynaardt's, the cover crop in plant-green treatment was about 24-in. tall at termination while the cover crops in plant-green treatments at Boyer's and Holl's were about 10-in. tall at termination (**Figure 1**). The extra cover crop growth at Fynaardt's could have competed with the corn for water and nutrients, slowing corn development and ultimately resulting in reduced yields compared to where he terminated the cover crop six days before planting corn. In fact, we saw similar results as we did in 2020, during which it appeared Fynaardt's corn in the plant-green treatment emerged through a larger cover crop than at the other farms and was the only one to experience yield drag.[5]

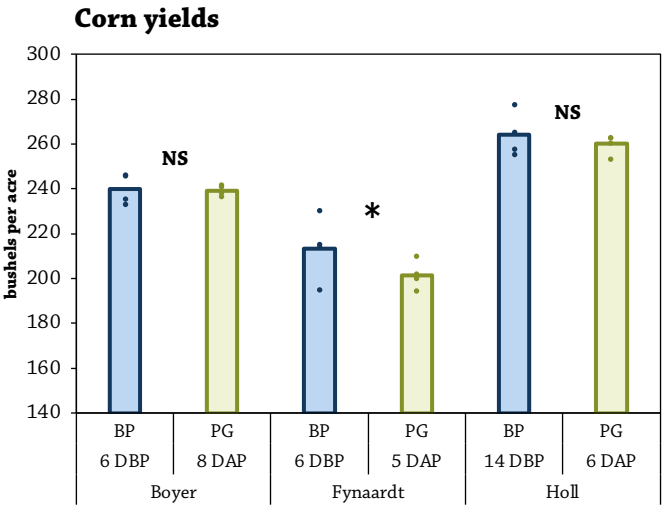


FIGURE 2. Corn yields as affected by cover crop termination date at Boyer's, Fynaardt's and Holl's farms in 2021. Columns represent treatment means at each farm; points represent the yield from individual strips. Asterisks (*) indicate statistical differences at the 95% confidence level. NS indicates no statistical difference. We determined statistical significance using the least significant difference (LSD). By farm: Boyer, LSD = 11 bu/ac; Fynaardt, LSD = 9 bu/ac; Holl, LSD = 13 bu/ac. Treatment abbreviations: BP = before-plant; PG = plant-green; DBP = days before planting corn; DAP = days after planting corn.

Seedling measurements

In early June, Dr. Robertson's lab group observed no effect of the cover crop termination date on corn stand density at any of the farms (**Table 3**). At Fynaardt's only, planting green reduced both seedling shoot (by 46%) and root weight (by 21%) compared to where he terminated the cover crop before planting corn. These results align with previous observations from lab and field studies by the group in which corn seedling shoot weight and root weight was reduced as the interval between cover crop termination and corn planting narrowed.[4] Just as Fynaardt observed this year (**Figure 2**), Dr. Robertson's lab group linked reduced seedling shoots and roots with reduced corn yield in their previous study. At the other three farms in the present study, they detected no effect of cover crop termination date on seedling shoot or root weight.

TABLE 3. Early-season corn measurements at each farm in 2021.

		STAND DENSITY (no./ac)	SEEDLING SHOOT WEIGHT (g)	SEEDLING ROOT WEIGHT (g)
Boyer	Before-plant	31,375 a	2.61 a	0.87 a
	Plant-green	33,375 a	2.78 a	0.99 a
	Trt. diff.	2,000	0.17	0.12
	LSD	10,828	4.89	0.91
Fynaardt	Before-plant	32,500 a	3.59 a	1.15 a
	Plant-green	33,000 a	1.93 b	0.91 b
	Trt. diff.	500	1.66	0.24
	LSD	1,949	1.05	0.07
Holl	Before-plant	35,875 a	5.24 a	1.58 a
	Plant-green	35,500 a	6.09 a	1.62 a
	Trt. diff.	375	0.84	0.04
	LSD	1,506	3.39	0.71
Stout	Before-plant	34,750 a	8.48 a	1.84 a
	Plant-green	33,875 a	6.14 a	1.44 a
	Trt. diff.	875	2.34	0.40
	LSD	6,277	4.24	0.59

Stand and seedling measurements: Boyer, Fynaardt, Holl = June 2; Stout = June 4.
By farm and response variable (columns), if the numerical difference between treatments is greater than the least significant difference (LSD), we consider the treatments to be statistically different with 95% confidence – represented by treatment values followed by different letters.

Ear and stalk measurements

In mid-September, Dr. Robertson's lab group returned to the farms to determine the number of barren plants and assess the amount of stalk rot in each strip. At none of the farms did they detect an effect of cover crop termination date on these late-season measurements.

TABLE 4. Late-season corn measurements at each farm in 2021.

		BARREN PLANTS (no.)	STALK ROT INDEX
Boyer	Before-plant	1.2 a	0
	Plant-green	0.8 a	0
	Trt. diff.	0.4	--
	LSD	1.5	--
Fynaardt	Before-plant	0.6 a	0.1 a
	Plant-green	0.5 a	0.0 a
	Trt. diff.	0.1	0.1
	LSD	0.4	0.2
Holl	Before-plant	0.5 a	0.1 a
	Plant-green	1.3 a	0.0 a
	Trt. diff.	0.8	0.1
	LSD	1.0	0.2
Stout	Before-plant	1.8 a	0.2 a
	Plant-green	2.3 a	0.3 a
	Trt. diff.	0.5	0.1
	LSD	4.0	0.3

Boyer, Fynaardt, Holl = Sept. 16; Stout = Sept. 24.
By farm and response variable (columns), because the difference between treatments is less than the least significant difference (LSD), we consider the treatments statistically similar with 95% confidence – represented by treatment values followed by the same letter.
Stalk rot was assessed using the University of Illinois Stalk Rot Rating Scale of 0 (no visible discoloration) to 5 (stalk lodged due to rot).

Previous research in Iowa by Dr. Robertson's lab linked planting green to reduced corn stands, increased number of barren plants and reduced corn yields.[4] They attributed these findings to increased levels of seedling disease compared to where the cover crop was terminated at least 10 to 14 days prior to planting corn. Yearly and seasonal variation as well as crop management can influence the prevalence of crop pathogens (such as *Pythium* and *Fusarium* species that cause seedling disease in corn). In this year's study, conditions at Boyer's, Holl's and Stout's farms may not have been suitable for corn seedling disease pathogens regardless of cover crop termination date.

CONCLUSIONS AND NEXT STEPS

After two years of study, planting green did not reduce yields in five of seven instances. In the remaining two instances, both of which occurred at Fynaardt's, planting green statistically reduced corn yields by 5–6%. From samples collected at all farms over the two years, Dr. Robertson's lab detected evidence of corn seedling disease only once: at Fynaardt's in June 2021 from the plant-green treatment. In both years, it appeared that corn at Fynaardt's emerged through much more cover crop in the plant-green treatment compared to the other farms. The reduced corn yields he observed may have been due to early-season competition for resources between the cover crop and the corn, seedling disease pressure or both.

Boyer, Holl and Stout learned that planting green may in fact be a viable practice for their farms going forward. Each of them is keen to allow a cover crop to grow as long as possible in the spring (up until corn planting) in order to maximize soil health benefits. From their results, the sweet spot for success might involve a cover crop that is no more than a foot tall as well as the ability to apply at least 30 units of N/ac with the planter.

APPENDIX – TRIAL DESIGN AND WEATHER CONDITIONS

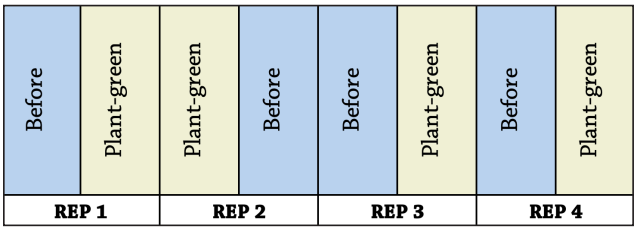


FIGURE A1. Sample experimental design used by the cooperators. The design includes replications of the two cover crop termination date treatments. This design allowed for statistical analysis of the results.

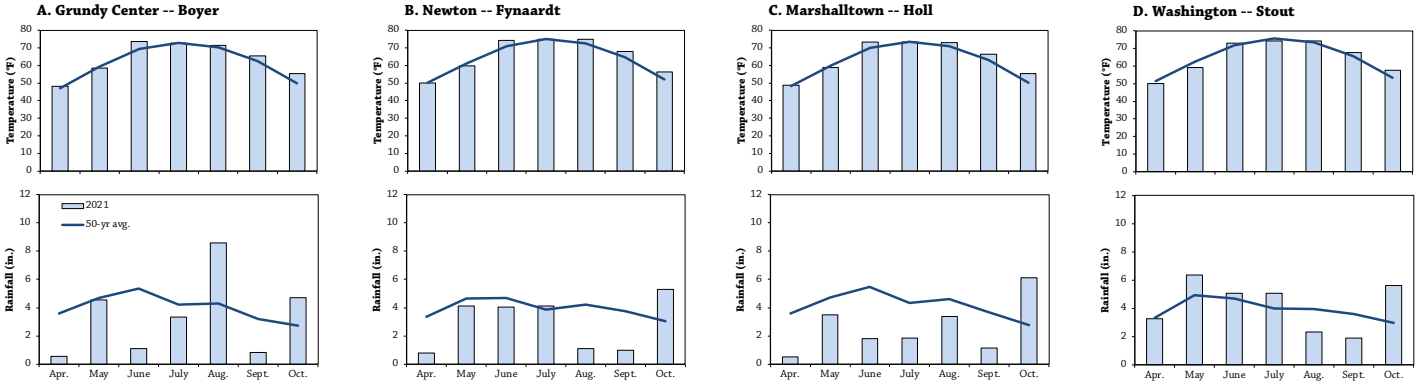


FIGURE A2. Mean monthly temperature and rainfall for 2021 and the long-term averages at the nearest weather stations to each farm.[7] A) Grundy Center (Boyer); B) Newton (Fynaardt); C) Marshalltown (Holl); D) Washington (Stout).

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