PRACTICAL farmers of Iowa

Field Crops Research

Corn Leaf Architecture for Interseeded Cover Crops

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In a Nutshell

- An earlier seeding date opens up the opportunity for more diverse cover crops like brassicas and legumes that need more time and heat units to grow than common cover crops like cereal rye.
- Two farmer-cooperators interseeded cover crops (cowpeas, annual ryegrass, rapeseed) into corn at the V4 stage in June. Corn hybrids chosen exhibited vertical and horizontal leaf orientations to test whether more light penetrating the corn canopy would encourage successful cover crop establishment and growth.

Key Findings

- Corn leaf orientation and corn planting population did not appear to have much of an effect on the interseeded cover crops.
- Jack Boyer saw corn yields reduced by an average of 24 bu/ac due to the interseeded cover crops.

Project Timeline
2017

Corn interseeded with cowpeas at Jack Boyer's on Oct. 18, 2017

Background

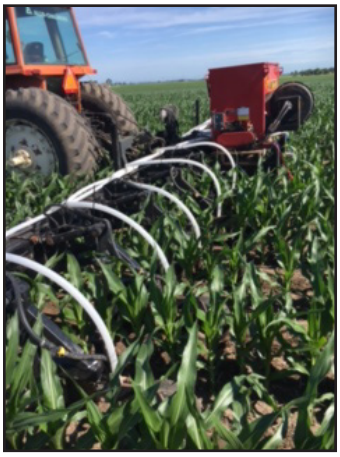
In Iowa, cover crops are typically either aerially seeded into standing corn around the time of physiological maturity in late summer or drilled immediately following corn harvest in the fall. However, the earlier one can seed a cover crop, the more potential for growth and biomass production. An earlier seeding date also opens up the opportunity for more diverse cover crops like brassicas and legumes that need more time and heat units to grow than common cover crops like cereal rye. In the past few years, researchers in Pennsylvania and Wisconsin (Roth et al., 2015) and Minnesota (Wells and Noland, 2016) have been investigating the practice of interseeding cover crops into corn with a modified, high-clearance drill seeder when the corn is six to eight inches tall (approx. V4-V5 stage of development). Researchers in South Dakota have found success with interseeding clover, lentil and winter wheat cover crops to standing corn at V5 with no negative effect on corn yield (Bich et al., 2014). Corn populations in that study ranged from 25,000–32,000 plants/ac. PFI farmer-cooperators have also investigated this technique. In 2015, Jack Boyer tried interseeding cereal rye into his commercial corn when it was about six inches tall (Gailans and Boyer, 2015). The rye sprouted and grew to five inches by early July but by September the rye was brown and dead; none of the rye survived in the dark below the corn canopy. In 2016, Boyer had success with establishing diverse cover crop mixes at the V4 stage in seed corn (Gailans and Boyer, 2017). The short stature of seed corn permitted plenty of sunlight to reach the soil surface and the cover crop seedlings. With that in mind, farmer-cooperators wondered if selecting commercial corn hybrids with "upright" leaf architecture would result in success with the interseeding technique. Such leaf architecture may allow more sunlight to reach the interseeded cover crops and increase the chances for the cover crops to persist through the rest of the growing season.

The objective of this research project was to determine if leaf architecture of corn affects the success of cover crop mixes interseeded to corn at the V4 stage. "Previous tests of interseeding cover crops in commercial corn were not successful," Boyer said. "I am searching for a protocol that will permit cover crops to survive below the canopy of commercial corn." "I want to see if the corn hybrid I use has any bearing on the success of interseeding cover crops," Jeremy Gustafson said, who also participated in this project. Ultimately, both farmer-cooperators were interested in reaping more cover crop growth and environmental benefit that could result from successfully establishing cover crops early in the growing season.

Methods

This research project was conducted by Jack Boyer of J Boyer Farms, Inc. near Reinbeck in Tama County in east-central Iowa and by Jeremy Gustafson near Boone in Boone County in central Iowa.

Treatments included two corn hybrids: one with a predominantly horizontal leaf architecture and one with a predominantly vertical leaf architecture. Additionally, Gustafson included a sub-plot treatment of plant population that ran perpendicular to the corn hybrid treatment strips. At both farms, treatments were replicated four times. Field operations for both farms are listed in **Table 1**.



Jeremy Gustafson interseeding cover crops on June 16, 2017 with a modified side-dress bar.

Table 1

Field operations at Jack Boyer's and Jeremy Gustafson's in 2017.

Farm	Boyer (Reinbeck)	Gustafson (Boone)
Corn planting date	Apr. 25	May 5
Plant populations (seeds/ac)	Horizontal: 35,000; Vertical: 35,000	Both hybrids: 30,000; 32,500; 35,000
N program	Apr. 12: 150 lb N/ac as anhydrous ammonia; Apr. 21: 30 lb N/ac as UAN; June 8: 50 lb N/ac as anhydrous ammonia side-dress	Pre-plant strip-till: 100 lb N/ac; Y-drop at tassel: 80 lb N/ac
Weed control	Apr. 21: 8 oz/ac paraquat + 12 oz/ac 2,4-D; May 5: 32 oz/ac atrazine 4L + 16 oz/ac Outlook; June 6: 32 oz/ac Liberty	May 4: 2.8 pt/ac Keystone; May 30: 0.75 oz/ac Impact
Cover crop mix seeding date	June 14	June 16
Cover crop mix seeding rates	cowpeas, 60 lb/ac; annual ryegrass, 22 lb/ac; rapeseed, 7 lb/ac	cowpeas, 60 lb/ac; annual ryegrass, 22 lb/ac; rapeseed, 7 lb/ac
Corn harvest date	Nov. 4	Oct. 25

At both farms, the two corn hybrids were planted on the same date. Boyer seeded each hybrid at the population recommended for that particular hybrid. Gustafson seeded both hybrids at each of the three populations he selected for the trial. At both farms, the cover crop mixes were seeded into all strips when the corn was six to eight inches tall (V4-V6 stage). Boyer used a Hiniker air drill (placing two rows between the corn rows) to accomplish this. Gustafson used a modified side-dress bar (lead coulter, blow seed in and then a closing wheel) to accomplish this.

Light sensors were installed in four strips at Boyer's to determine if the two corn hybrids permitted different amounts of sunlight to penetrate through the canopy and reach the soil surface. Sensors collected data once per hour every hour for each day beginning on June 17 and up until harvest.

Corn in each strip was harvested on the same date; yields were recorded for each individual strip and corrected to 15.5% moisture.

Data were analyzed using JMP Pro 12 (SAS Institute Inc., Cary, NC) and corn yield comparisons employ least squares means for accuracy. Statistical significance is determined at $P \leq 0.05$ level and means separations are reported using Tukey's Least Significant Difference (LSD).

Jack Boyer interseeding cover crops on June 14, 2017 with a modified Hiniker air drill.

Results and Discussion

Mean monthly temperature and total monthly rainfall near Boyer's and Gustafson's farms compared to the long-term averages is presented in **Figure 1.** Temperatures in 2017 did not deviate from the long-term normal. June and July were particularly dry at Gustafson's and July was particularly dry at Boyer's.

Boyer and Gustafson seeded the cover crop mix into their corn in mid-June when the corn was approximately six inches tall. Aboveground biomass of the cover crop mixes was not sampled but photographic evidence shows that cover crops persisted beneath the corn canopy into early fall at both farms.

Boyer saw decent growth of the interseeded cowpeas regardless of the leaf architecture during the summer. The light sensors showed no difference in sunlight penetration through the canopy between the two leaf architectures (data not shown). One thing Boyer did observe, however, was the lack of nodulation on the legume's roots despite having inoculated the cowpea seed with the appropriate Rhizobium species. Boyer attributed this to rather high soil NO_3-N levels when sampling in late September (22 ppm) as well as dry soil conditions for most of the summer **(Figure 1)**. While digging up the cowpea roots to inspect for nodules, Boyer did notice that there were several earthworms in those shovelfuls of soil; a small marker of improved soil health. By the time of harvest, cool temperatures had killed much of the cowpeas—a tropical plant—leaving only the annual ryegrass and rapeseed.

Figure 1

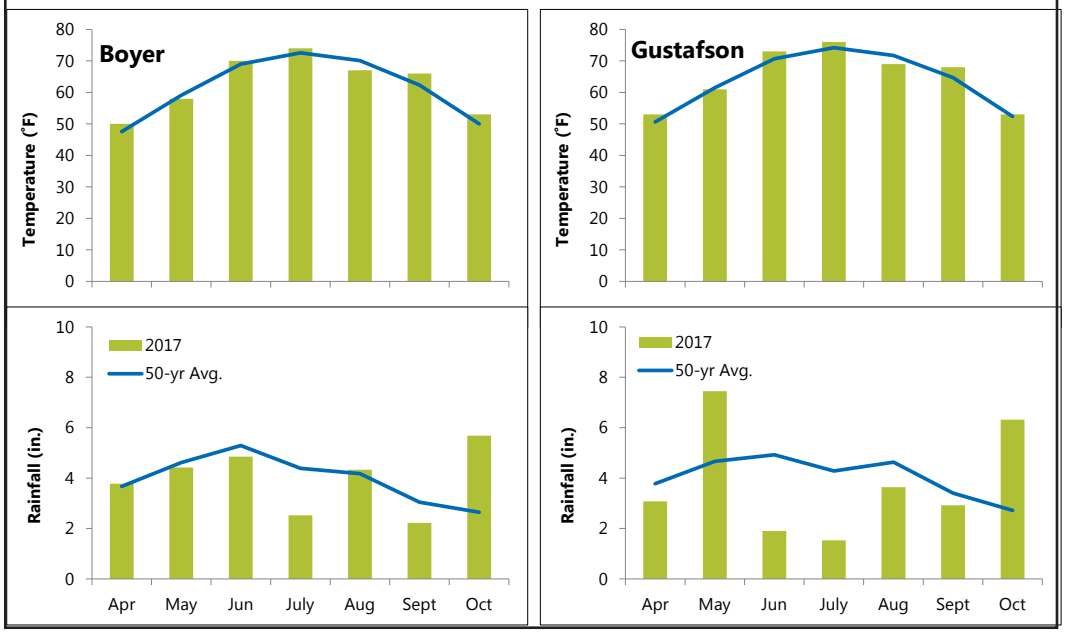


Figure 1. Mean monthly temperature and rainfall for 2017 and the 50-yr averages at the Grundy Center weather station (approx. 10 mi. from Boyer's) and at the Ames weather station (approx. 4 mi from Gustafson's) (Iowa Environmental Mesonet, 2017).

Figure 2

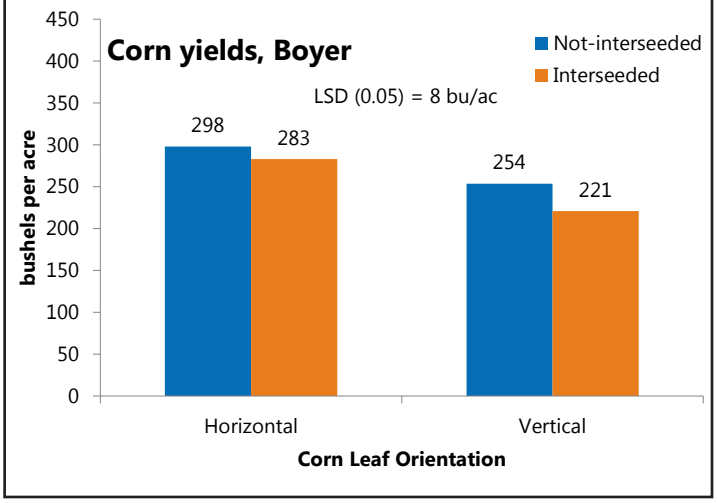


Figure 2. Corn yields at Jack Boyer's farm (Reinbeck) as affected by corn leaf orientation (horizontal vs. vertical) and the interseeded cover crop mix in 2017. If the difference in yield between any two treatments is greater than the least significant difference (LSD), the treatments are considered significantly different with 95% certainty.

Clockwise from upper left: Cover crops emerging in interrow on June 19; Interseeded cowpeas in mid-August; Cowpea roots with no nodules in mid-August; Cover crop mix in mid-October after some frost events at Jack Boyer's in 2017.

"The seed germinated well," Gustafson said, seeing mostly cowpeas by mid-September. "Not much made it into fall, though. Leaf architecture didn't seem to matter and lack of rain really played havoc with this trial" **(Figure 1)**.

Corn yields at Boyer's were mostly affected by the hybrid planted: The hybrid with the horizontal leaf architecture out-yielded the one with the vertical leaf architecture **(Figure 2)**. "Part of yield difference between vertical and horizontal leaf architectures are variety differences, as those differences were observed across the field and in other fields, to more or less degree," Boyer said. Regardless of leaf architecture, the corn yielded better when not interseeded with the cover crop mix. This finding runs contrary to the trial Boyer conducted the year prior with seed corn. In that previous trial, the cover crop interseeding had no effect on seed corn yield (Gailans and Boyer, 2017). Despite reductions in corn yields occurring with the interseeding in the current study, yields were well above the 5-year average for Tama County of 180 bu/ac (USDA-NASS, 2017).

Corn yields at Gustafson's were not affected by any of the treatments **(Figure 3)**. Regardless of leaf architecture or planting population, corn yield averaged 243 bu/ac with the cover crop interseeding occurring in each of the treatments. Though a true no-cover check treatment was not included in Gustafson's trial, the rest of his field, where no cover crop was interseeded, averaged 252 bu/ac. The 5-year corn yield average for Boone County is 177 bu/ac (USDA-NASS, 2017).

Figure 3

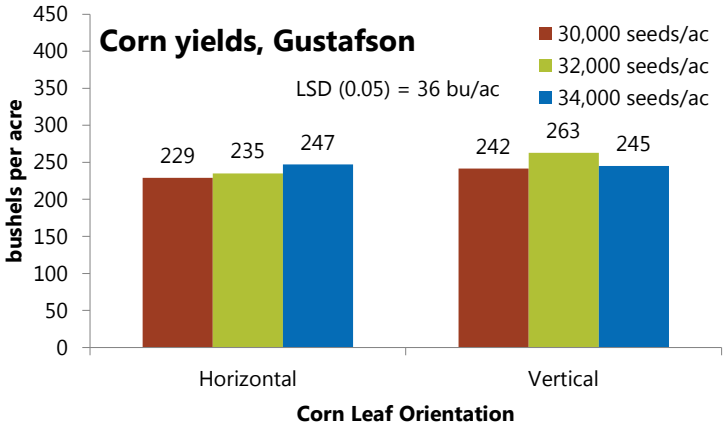


Figure 3. Corn yields at Jeremy Gustafson's farm (Boone) as affected by corn leaf orientation (horizontal vs. vertical) and planting population 2017. All treatments were interseeded with the cover crop mix.

Conclusions and Next Steps

These on-farm research trials investigated the interseeding of cover crops to commercial corn at the V4 stage as a potential establishment method. Anecdotal reports from other farmers trying this interseeding method have noted some success with cowpeas especially when grazing the cowpeas and cornstalks in the fall is a goal. The farmer-cooperators involved in the present trial tested corn leaf architecture (as determined by hybrid planted) and planting population as means to determine if more light penetrating through the corn canopy would allow for more successful cover crop establishment and growth. From visual inspection of the cover crops, neither cooperator observed much of an effect of corn leaf architecture or corn planting population on the growth of the cover crops. Cowpeas dominated the mix during the summer months while annual ryegrass and rapeseed persisted up until harvest after some frost events.

Jack Boyer did see some yield drag this year from the interseeded cover crops **(Figure 2)**. "This technique requires more testing before wide spread adoption," he said. "I need to understand what caused the yield hit. The cover crop species I interseeded worked with both corn varieties, so I will probably try another interseeding with just one variety."

Interseeded cowpeas (left) and nodulated cowpea roots at Jeremy Gustafson's on Sept. 13, 2017.

References

Bich, A., C. Reese, A. Kennedy, D. Clay, and S. Clay. 2014. Corn yield is not reduced by mid-season establishment of cover crops in Northern Great Plains environments. Crop Management 13.

Gailans, S. and J. Boyer. 2015. Interseeding cereal rye into corn at the V4 stage at Jack Boyer's in 2015. Practical Farmers of Iowa blog post. Ames, IA. http://practicalfarmers.org/blog/2015/10/29/interseeding-cereal-rye-into-corn-at-v4-stage-at-jack-boyers-in-2015/ (accessed Dec. 29, 2017).

Gailans, S. and J. Boyer. 2017. Interseeding cover crops in seed corn at the V4-V6 stage. Practical Farmers of Iowa Cooperators' Program. Ames, IA. URL. (accessed Dec. 29, 2017).

Iowa Environmental Mesonet. 2017. Climodat Reports. Iowa State University, Ames, IA. http://mesonet.agron.iastate.edu/climodat/ (accessed Dec. 29, 2017).

Roth, G., W. Curran, C. Dillon, C. Houser, and W. Harkcom. 2015. Cover Crop Interseeder and Applicator. Penn State Extension. State College, PA. http://extension.psu.edu/plants/crops/soil-management/cover-crops/interseeder-applicator (accessed Dec. 29, 2017).

US Department of Agriculture-National Agricultural Statistics Service. 2017. Quick stats. USDA-National Agricultural Statistics Service, Washington, DC. http://quickstats.nass.usda.gov/ (accessed Dec. 29, 2017).

Wells, M. and R. Noland. 2016. Optimization of cover crop establishment technologies in corn-based cropping system. Univ. of Minnesota. St. Paul, MN. http://www.extension.umn.edu/agriculture/forages/presentations/docs/wells-wintercrop-2016.pdf (accessed Dec. 29, 2017).

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