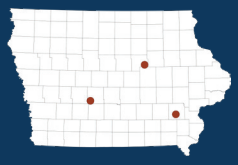
PRACTICAL FARMERS OF IOWA
COOPERATORS' PROGRAM Farmer-Led Research

EXPERIMENT



2024

Biochar Seed Treatment for Corn

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In a Nutshell:

- Biochar is a fine-grain charcoal material produced by heating organic materials such as wood or straw to a very high temperature in the absence of oxygen. Biochar contains a high proportion of organic carbon (at least 10%) and breaks down very slowly in soil conditions.
- Field crops farmers have been hearing a lot about using biochar as a corn seed coating to enhance seedling establishment, plant growth and yields. Jack Boyer, Robert Harvey, and Rob Stout decided to test how using EarthBrew, a biochar product, as a seed coat affected corn yields.

Key Findings:

- Harvey and Stout found that using biochar as a seed coat modestly increased corn yield by 6 and 10 bu/ac, respectively.
- Boyer found no difference in yield between his corn treated with biochar and his corn that was not treated.

Cooperators

Jack Boyer – Reinbeck, IA

Robert Harvey – Redfield, IA

Rob Stout – Washington, IA

Funding

Cargill

BACKGROUND

If you follow news about new soil amendments or agricultural soil carbon sequestration, you have probably heard at least a little bit about biochar. It is a fine charcoal material produced by heating organic materials (wood, straw, etc.) to a very high temperature in the absence of oxygen. Biochar is a very porous material that is able to physically and chemically hold onto nutrients such as N and P, heavy metals, dissolved organic carbon, and water [1]. As such, biochar has garnered a steadily growing interest as an amendment from scientists and farmers for well over a decade, with increasing numbers of academic articles published each year and new products cropping up in catalogs and on store shelves.

Biochar and other forms of black carbon produced by incomplete burning make up a significant portion of the stable organic carbon stored in soils globally, especially in regions that were historically grasslands such as the American Midwest [2], [3]. Some humans have also historically added large quantities of char to soil to change soil characteristics and improve soil fertility, most famously in the terra preta soils of the Amazonian basin [3]. Today's commercially available biochar products often promise to increase yield, water retention, nutrient availability and soil carbon storage. However, farmers and researchers have found mixed results from the use of biochar as an agricultural amendment; a 2012 global review found that 50% of studies on biochar amendments found that biochar did not impact yield or negatively impacted yield [4]. Reviews have generally found that biochar improves soil and yield in low-nutrient and sandy soils and increases soil microbial activity, but its usefulness in terms of yield impacts on already rich soils like those we have in Iowa is less clear [1].

Today, biochar products are often marketed to farmers as a soil amendment meant to be applied in the order of tons per ac, but also as a seed coating or soil amendment meant to be used in small or very small quantities. In 2024, Jack Boyer, Robert Harvey and Rob Stout decided to test whether one biochar + compost tea product, EarthBrew, affected their corn yield when used as a seed coating at the manufacturer's recommended rate. All three farmers cited the potential to increase yields and improve profitability as the reason why they were interested in the trial.

METHODS

Design

Boyer, Harvey and Stout each planted corn in two treatments, biochar (applied as seed coating) and no biochar, in spring of 2024. Planting and management details on each farm are presented in **Table 1**. Biochar was applied at the manufacturer's recommended rate of 1/3 cup per 50-lb bag of seed. Cooperators established treatments in randomized, paired strips: 2 treatments × 4 replications = 8 strips total (**Figure A1**).

TABLE 1: Corn management practices at Jack Boyer's, Robert Harvey's and Rob Stout's in 2024.

	BOYER	HARVEY	STOUT
Previous crop	Soybeans	Soybeans	Soybeans
Cover crop planting	Oct. 10, 2023 Cereal rye	Sept. 14, 2023 Cereal rye flown on 70 lb/ac	Oct. 15, 2023 Cereal rye seeded at 65#/ac with a drill on 10-in. spacing
Cover crop termination	Apr. 17, 2024 Roundup	Apr. 14, 2024 2,4-D and Roundup	Apr. 13, 2024 Roundup
Biochar application	EarthBrew Coated by mixer	EarthBrew Coated by mixer	EarthBrew
Strip size	15 ft x 1,800 ft	15 ft x 1,154 ft	15 ft x 900 ft
Corn planting date	May 17, 2024 34,000 seeds/ac on 30-in. rows	Apr. 24, 2024 31,000 seeds/ac on 30-in. rows	May 11, 2024
Fertilizer	Not provided	Jun. 11, 2024 130 lb/ac N applied as UAN	Apr. 13, 2024 31 lb/ac N as UAN Apr. 23, 2024 140 lb/ac N as urea May 11, 2024 20 lb/ac N, 76 lb/ac P, 12 lb/ac K and 4 lb/ac S as starter and 31 lb/ac N as UAN June 11, 2024 50 lb/ac N as urea
Weed management	Not provided	Roundup and 2,4-D pre-plant; Roundup and Zidua post-plant	Keystone, Sotrion, and Roundup PowerMax 3 post-plant
Corn harvest	Oct. 15, 2024	Oct. 14, 2024	Oct. 15, 2024

Measurements

All three farmers recorded grain yield and moisture using a yield monitor or weigh wagon. Reported corn yields are corrected to 15.5% moisture. Harvey also documented costs of equipment passes and applied products.

Data analysis

To evaluate whether treatment affected corn yield at each farm individually, we conducted a two-way ANOVA that accounts for treatment and replicate location at the 95% confidence level. We followed the ANOVA with a Tukey's test which produces an Honest Significant Difference (HSD) statistic. If the difference in corn yield between the two treatments was greater than the HSD, we say that the biochar treatment significantly affected yield. We would expect such a difference to occur 95 times out of 100 under the same conditions. On the other hand, if the resulting difference between the two treatments was less than the HSD, we would say that biochar did not affect corn yield. We can perform this analysis because the cooperators had completely randomized and replicated experimental designs (**Figure A1**).

RESULTS AND DISCUSSION

Two of the three participating farmers found that biochar as a seed treatment significantly increased their corn yield (**Figure 1**). Harvey found that his biochar-treated corn (216 bu/ac) yielded 6 bu/ac higher than his untreated corn (210 bu/ac), and Stout similarly found that his biochar-treated corn (236 bu/ac) yielded 10 bu/ac higher than his untreated corn (226 bu/ac). Stout reports, "Although I was a skeptic up until harvest, I had positive yield results. I am going to try biochar on more acres next year." In contrast, Boyer found no significant difference in yield between his biochar treated (240 bu/ac) and untreated (230 bu/ac) corn because there was a lot of variability in yield within his biochar treatment (dots in **Figure 1**). Boyer has tried biochar before and he remarks that these were "different results from last year's positive yield improvement [in my trial]. Seeing the variability from year to year was valuable."

Harvey found that his 6 bu/ac yield boost was more than enough to pay for the cost of the EarthBrew product, which cost him $3.52/ac. He saw a $22/ac profit boost in his biochar seed-treated corn. The cooperators generally noted that coating the seed with a mixer and planting the treated seed on a trial-sized area was quite easy, but Harvey is not sure that it would work well for him to use biochar-coated seed on his whole operation because of the size of his mixer. "I need to determine if different equipment is needed to change application methods on all my farm."

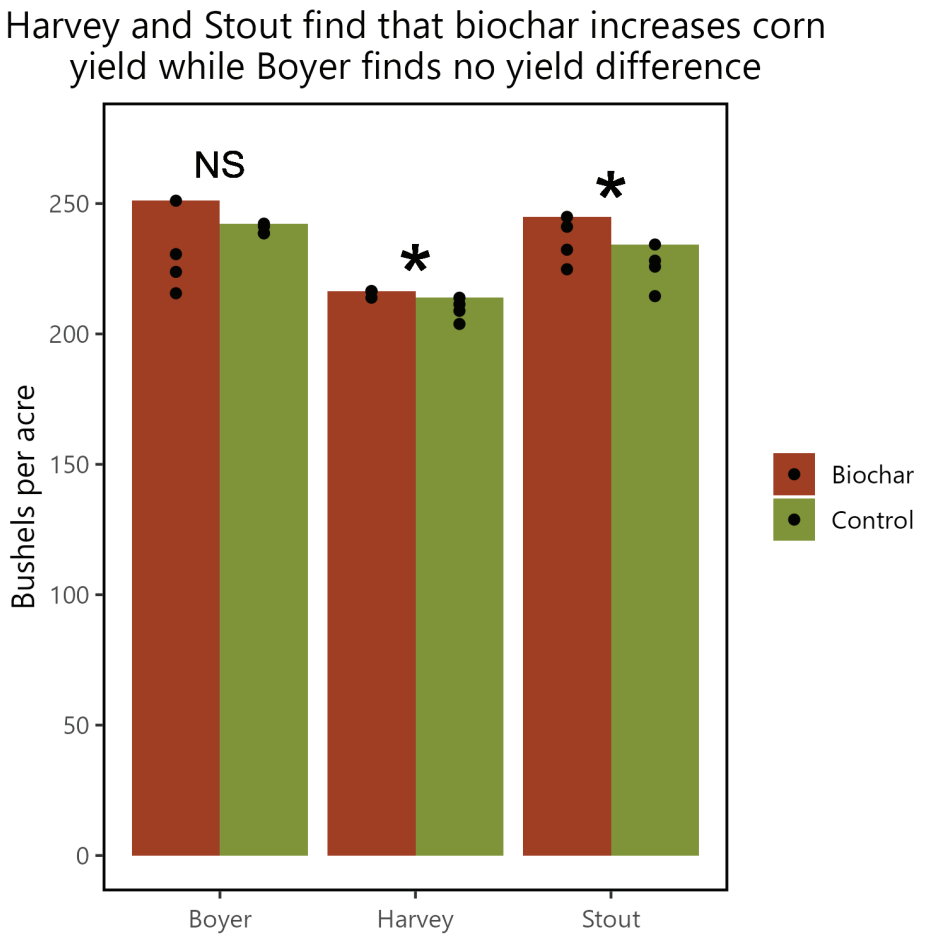

FIGURE 1: Corn yields by treatment on all three participating farms in 2024. Dots on bars indicate the yield of individual replicates within each treatment. Asterisks (*) indicate a significant difference in yield between treatments on an individual farm at the 95% confidence level, while NS indicates no significant difference. We determined statistical significance using the honest significant difference (HSD). By farm: Boyer, HSD = 19 bu/ac; Harvey, HSD = 2 bu/ac; Stout, HSD = 8 bu/ac.

CONCLUSIONS AND NEXT STEPS

Two of the three farmers who trialed using biochar as a seed treatment on their corn in 2024 found that it increased the yields of their corn crop. Harvey, who found that biochar increased his corn yields this year, nevertheless says that, based on past observations and Boyer's results, that this may not be the outcome in every year or field in which he uses biochar as seed treatment. He says that in the future "hopefully more farmers will participate" so that they can get an even better idea of how biochar affects corn yields in different situations. PFI will continue to support farmers as they investigate the impact that biochar and other seed treatments can have on their yields and budgets.

APPENDIX – TRIAL DESIGN AND WEATHER CONDITIONS

	Control	Biochar	Biochar	Control	Control	Biochar	Biochar	Control
STRIP	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
REP	**1**		**2**		**3**		**4**	

FIGURE A1. Example experimental design used by trial participants.

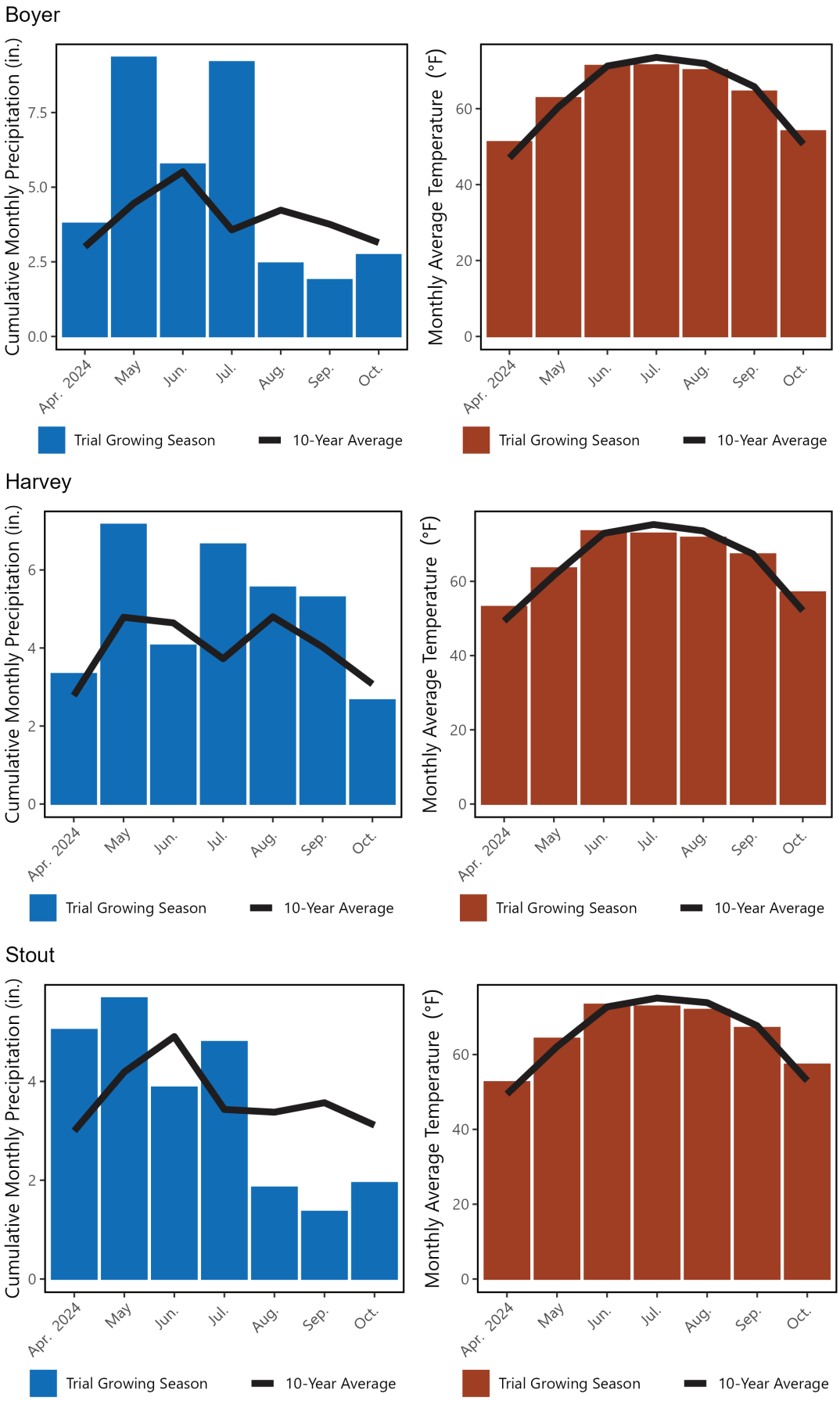

FIGURE A2. Modelled mean monthly temperature and rainfall at each trial site during the study period and the ten-year historic averages. Data is from the NasaPOWER climate dataset. [5, 6]

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PRACTICAL FARMERS of Iowa

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PFI's Cooperators' Program helps farmers find practical answers and make informed decisions through on-farm research projects. The Cooperators' Program began in 1987 with farmers looking to save money through more judicious use of inputs.
If you are interested in conducting an on-farm trial contact Stefan Gailans @ 515-232-5661 or stefan.gailans@practicalfarmers.org.