2017 eFields Report

OSU Digital Ag Program

The Ohio State University

COLLEGE OF FOOD, AGRICULTURAL, AND ENVIRONMENTAL SCIENCES

COLLEGE OF ENGINEERING

@OhioStatePA @OhioStatePA DigitalAg@osu.edu

“Connecting Science to Fields.”

eFields represents an Ohio State University program dedicated to advancing production agriculture through the use of field-scale research. This program utilizes modern technologies and information to conduct on-farm studies with an education and demonstration components. Insights are used to help farmers and their advisors understand how new practices and techniques can improve farm efficiency and profitability. The program is also dedicated to delivering timely and relevant, data-driven, actionable information. Current projects focus on precision nutrient management strategies and technologies to improve efficiency of fertilizer placement, automate machinery, enhance placement of pesticides and seed, and to develop analytical tools for digital agriculture.

Ohio State Digital Ag Program

VISION

To be the premier source of research-based information in the age of digital agriculture.

MISSION

- Uniting the private and public sectors to drive innovation for the benefit of farmers.
- Partnering with farmers to translate innovation into long-term profitability for production agriculture.
- Delivering timely and relevant information for the advancement of digital agriculture technologies.

2017 Research Recap:

New for 2017:

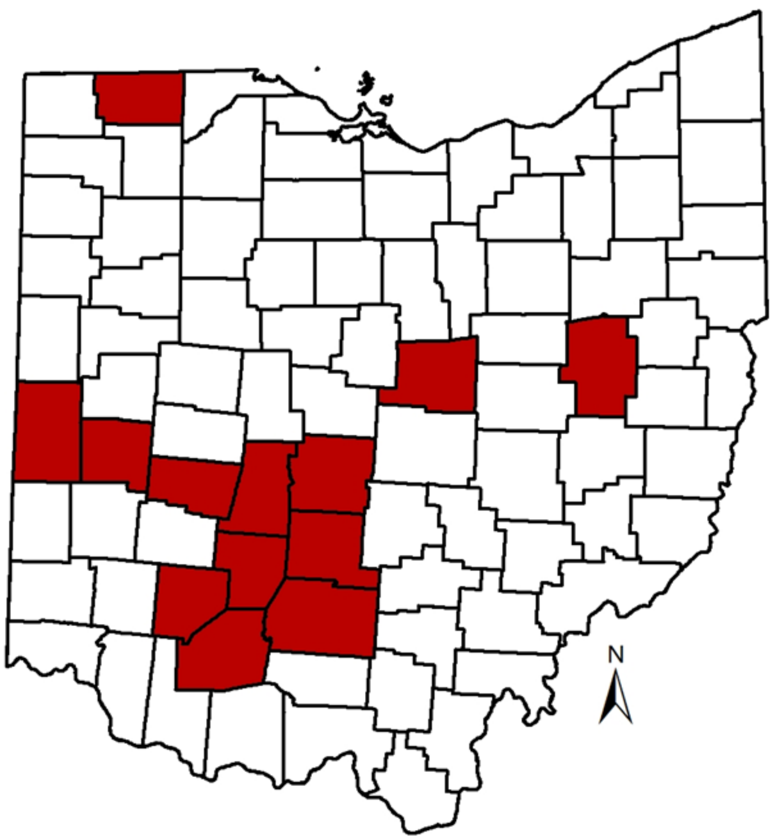
- Pinch Row Compaction Soybeans
- Strip-Till Studies
- Manure Sidedress
- Remote Sensing

3121 Total Acres

39 eField Collaborating Farms

Crop Break Down

- 2090 acres Corn
- 1018 acres Soybean
- 13 acres of Corn and Soybean intercropping



13 counties, 39 on-farm research sites, and over 3000 acres

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eFields Report Contributors - Faculty and Staff

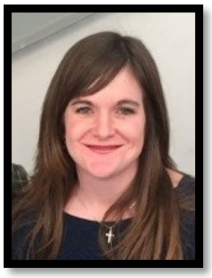
Glen Arnold

Associate Professor, Field Specialist, Manure Nutrient Management Systems

Department of Extension

- Nutrient Management
- Liquid Livestock Manure
- In-Season Manure Application

Amanda Bennett



Extension Educator, Miami Co.

Department of Extension

- Farm Management
- Micronutrients
- Seeding Rates

Chris Bruynis

Extension Educator, Ross Co.

Department of Extension

- Farm Management
- Micronutrients
- Seeding Rates

Trey Colley

Graduate Research Associate

Department of Food, Agricultural and Biological Engineering

- Ag Data Management
- Precision Nutrient Management
- On-farm Digital Strategies

Sam Custer

Extension Educator, Darke Co.

Department of Extension

- Farm Management
- On-farm Research
- Agronomy

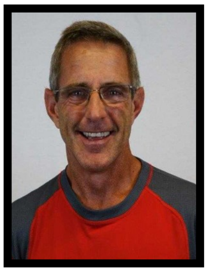
Nate Douridas

Farm Manager

Molly Caren Agricultural Center

- Farm Management
- Site Specific Crop Production
- Ag Equipment and Technology

Mike Estadt



Extension Educator, Pickaway Co.

Department of Extension

- Biologicals
- Narrow Row Corn
- Wheat Yield and Quality

Ken Ford

Extension Educator, Fayette Co.

Department of Extension

- On-farm Research
- Farm Management
- Resource Management

Dr. John Fulton

Associate Professor

Department of Food, Agricultural and Biological Engineering

- Machinery automation
- Site-specific crop and soil amendment placement
- Data analysis for farm business and in-season decisions

Mary Griffith

Extension Educator, Madison Co.

Department of Extension

- Pest Management
- Program Evaluation
- Crop Production

eFields Report Contributors - Faculty and Staff

Dr. Elizabeth Hawkins

Assistant Professor, Field Specialist, Agronomic Systems

Department of Extension

- On-farm Research
- Resource Management
- Implementation of technologies

Dr. Sami Khanal

Research Scientist

Department of Food, Agricultural and Biological Engineering

- Remote sensing
- UAS and data systems
- Compaction management

Andrew Klopfenstein

Senior Research Associate Engineer

Department of Food, Agricultural and Biological Engineering

- Compaction management
- Multi-hybrid seeding
- UAS and data systems

Jenna Lee

Student Assistant

Department of Food, Agricultural and Biological Engineering

- Ag Data Management
- ROI for Digital Tools
- Precision technology

Larry Anthony Nye

Assistant Professor, Extension Educator, Clinton Co.

Department of Extension

- Crop Production
- Fertility
- Insects

Kaylee Port

Precision Ag Program Manager

Department of Food, Agricultural and Biological Engineering

- Program planning, coordination
- Resource management systems
- Project specialist

Eric Richer

Extension Educator, Fulton Co.

Department of Extension

- On-farm Research
- Agronomy
- Farm Management

Dr. Scott Shearer

Professor and Chair

Department of Food, Agricultural and Biological Engineering

- Compaction Management
- Remote Sensing
- Data systems and data management

Ryan Tietje

Research Associate Engineer

Department of Food, Agricultural and Biological Engineering

- Field Operations
- Compaction management
- Precision crop management

Chris Zoller

Associate Professor, Extension Educator, Tuscarawas Co.,

Department of Extension

- Farm Management
- On-farm Research
- Livestock

eFields Report Guide

2017 DIGITAL AG INITIATIVES

Utilizing Technology to Feed the World

N-P-K

PRECISION NUTRIENT MANAGEMENT

Ensuring that all applied nutrients are in a position that maximizes crop uptake. Right source, right rate, right time, right place

PRECISION SEEDING

Utilizing the latest Digital Ag technologies to place every seed in an environment optimized for its growth and development

PRECISION CROP MANAGEMENT

Management of crop inputs in a way that maximizes efficiency and minimizes inputs

SOIL COMPACTION MANAGEMENT

As axle loads increase, soil compaction becomes more detrimental to yields

REMOTE SENSING

Providing the ability to understand crop health, nutrient needs, and productivity levels on a per-plant scale

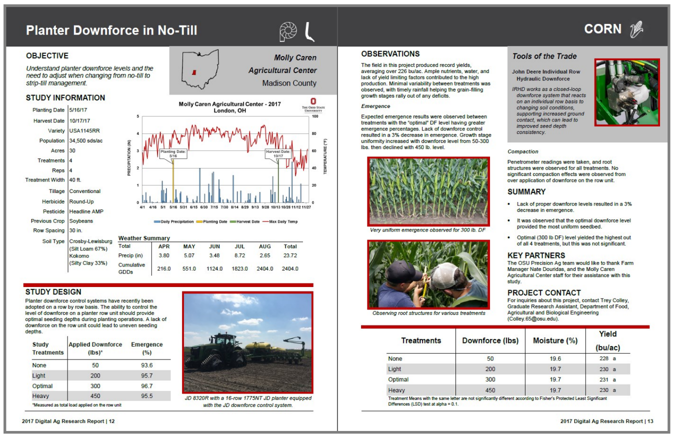
DATA ANALYSIS AND MANAGEMENT

Making "actionable decisions" from observed ag data, from insights to field exection

For more information about these initiatives and how they impact Ohio Agriculture, visit: https://fabe.osu.edu/programs/precisionag

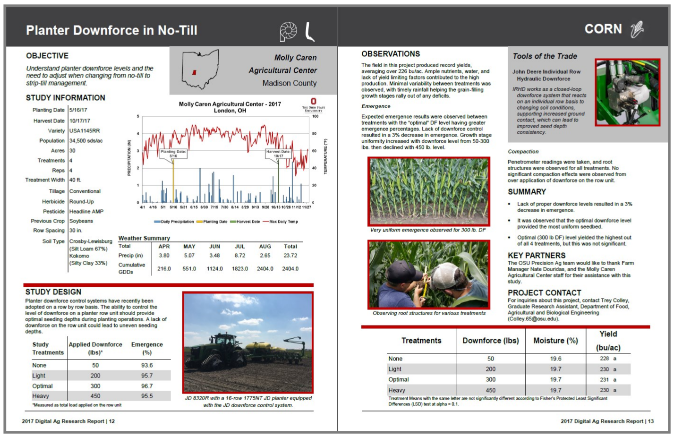
Thank you for taking the time to explore our 2017 **eFields** Report.

To help you find what you're looking for, we have organized the report by crop, (denoted in the **top right** corner of each study).



Corn studies begin on page 10, and soybean studies begin on page 62.

See the graphic to the **left** for a brief description of our 2017 Digital Ag Research Initiatives. Each study is also organized by the initiative associated with it (denoted by the icon(s) near the title of each study).



Calculations and Statistics

Statistical Calculations

All statistical calculations were conducted using the OSU PLOTS Research App or calculated using the ANOVA spreadsheet, using Fisher's Protected Least Significant Differences (LSD, alpha = 0.1) method to determine if treatment differences are statistically significant.

LSD: Least significant difference is used to compare means of different treatments that have an equal number of replications. For this report, a significance level of 0.1 (or 10%) was used, which means when a treatment is statistically significant, a 90% confidence is attributed to that treatment *actually* being different from the comparison.

CV: The CV is defined as the coefficient of variation, and is a measure of the variability between the treatment yields. In this report it is calculated as a percentage.

For example, take a look at this scenario from a study:

At a significance level of 0.1, the LSD value was 3.38 bu/ac.

- *For treatment A to be statistically significant than treatment B, they must differ by at least 3.38 bu/ac. (They are not, so they are not statistically different and are marked using the same letter).*

- *For treatment D to be statistically different from treatment A, they must differ by at least 3.38 bu/ac (here they differ by 5 bu/ac, so they are statistically significant and are marked using different letters).*

Treatments	Yield (bu/ac)
A	230 a
B	229 a
C	227 ab
D	225 b
	LSD 3.38 CV 1.60%

For this example, since treatment A is different from treatment D by 3.38 bu/ac, *we are 90% certain* that the treatments were indeed different. Treatment differences are represented by using a letter beside the reported value.

Since the averages for treatment A and treatment B differ by less than 3.38, we cannot conclude that the treatments are different from each other, so the same letter (eg. "a") is used to indicate they are the same.

Replication:

- Replication allows us to estimate the error associated with carrying out the experiment itself. A minimum of 3 replications are needed for a field study, with more than 3 recommended.
- Without replication, it would be impossible to determine what factor or definite cause contributed to any treatment differences.
- 3 or more replications across a field will help ensure treatments are thoroughly evaluated.

Randomization:

- Randomization is as important as replication to help account for any variations.
- Even if you replicated treatments, the conclusions you reach may not be correct if a treatment was always applied to the same part of the field.
- Randomization prevents data from being biased based on its location in a field.

Harvest Data

All yield data was collected using calibrated yield monitors. Data was then processed and cleaned to ensure accuracy before being analyzed.

For more information and examples on statistics and experimental setup, visit fabe.osu.edu/additionalresources and click "On-Farm Research".

Ohio State Corn Research

For 2017, the **eFields** research focus was related to improving the production and profitability of corn in the greater Ohio Area. Some exciting and innovating projects were executed this year, with over 20 unique studies being conducted across the state! Research topics covered many of the Digital Ag Team initiatives including: precision nutrient management, precision seeding, precision crop management, soil compaction management, remote sensing, and data analysis and management. Here are some of the highlights of 2017's **eFields** corn research:

2017 Corn Research

- 2,089 acres of Corn
- 21 individual corn studies

For more corn research from The Ohio State University's Department of Extension, explore the following resources:

2017 Ohio Corn Performance Test

The Ohio Corn Performance Test (OCPT) evaluates corn hybrids for grain yield and other important agronomic characteristics. Results of the test can assist farmers in selecting hybrids best suited to their farming operations and production environments. http://go.osu.edu/corntrials

Agronomic Crops Team—Corn Research

The Agronomic Crops Team performs interesting research studies on a yearly basis. Resources, fact sheets, and articles on corn research studies can be found here on the Agronomic Crops Team website: http://go.osu.edu/CropsTeamCorn

The Ohio State Precision Ag Program

The Ohio State Precision Ag Program conducts studies related to all aspects of the corn production cycle. Research related to corn planting, cropping inputs, and harvesting technology can be found on the Precision Ag website: www.OhioStatePrecisionAg.com

Growth Stages - Corn

For all corn studies in this eFields report, we define corn growth stages as the following:

VE - Emergence - coleoptile is fully visible, yet no leaves are fully developed.

V1 - Full development of the first (flag) leaf, achieved when the collar of the leaf is fully visible.

V_N - N fully developed leaves with collars visible.

VT - Tassels fully visible and silks will emerge in 2-3 days.

R1 - Silking - silks are visible and pollination begins.

R2 - Blister - silks darken and dry out, kernels are white and form a blister containing clear fluid.

R3 - Milk - kernels are yellow and clear fluid turns milky white as starch accumulates, kernels contain 80% moisture.

R4 - Dough - starchy liquid inside kernels has dough-like consistency, kernels contain 70% moisture and begin to dent at the top.

R5 - Dent - nearly all kernels are dented and contain about 55% moisture.

R6 - Black layer - physiological maturity is reached and kernels have attained maximum dry weight at 30-35% moisture.

Adapted from Stewart Seeds Corn and Soybean Growth Stages Guide, 2013.

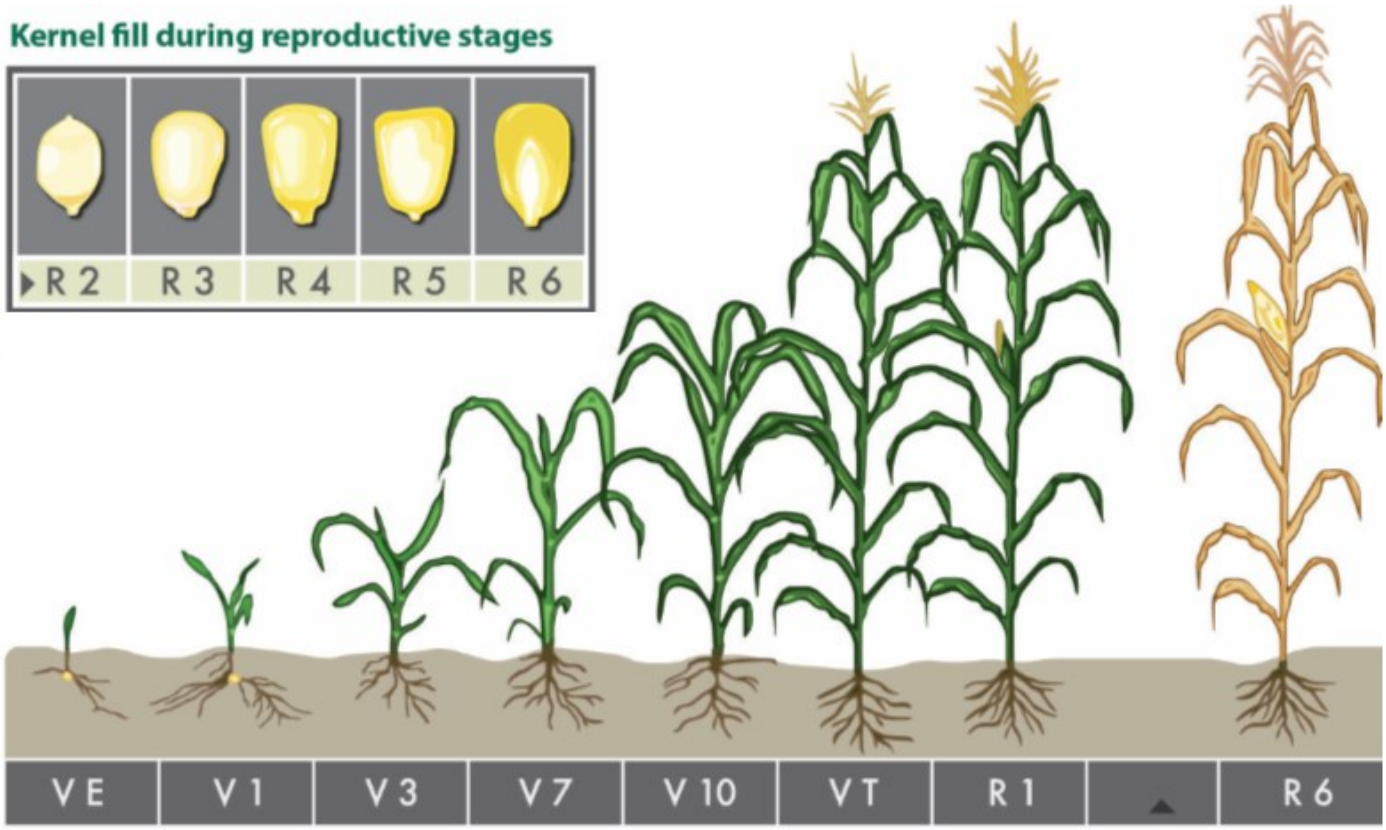


Image Source: University of Illinois Agronomy Guide, 1999.

Planter Downforce in No-Till

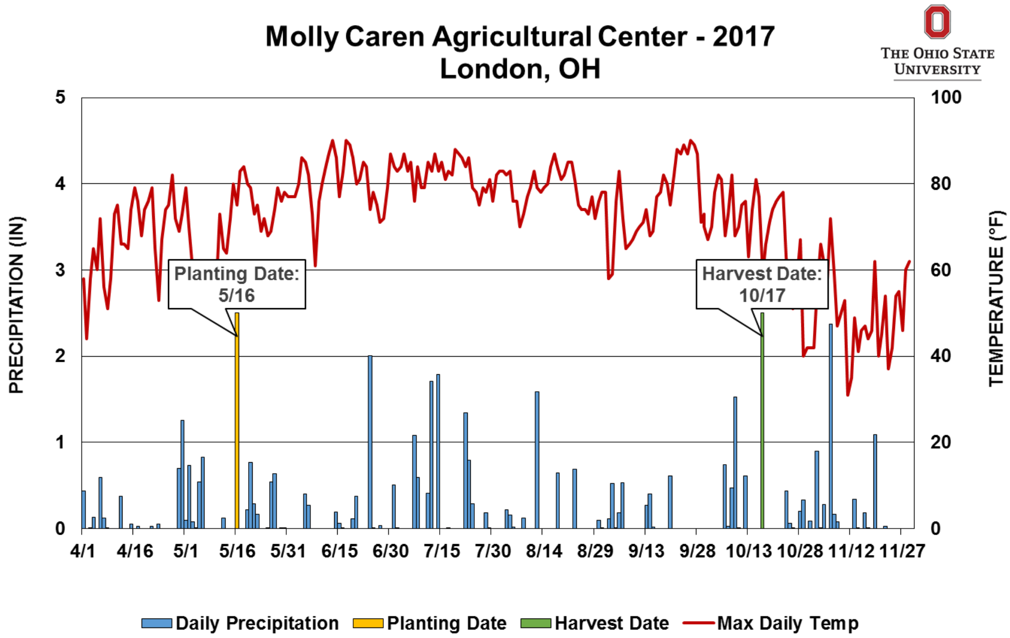
OBJECTIVE

Understand planter downforce levels and the need to adjust when changing from no-till to strip-till management.

Molly Caren
Agricultural Center
Madison County

STUDY INFORMATION

Planting Date	5/16/17
Harvest Date	10/17/17
Variety	USA1145RR
Population	34,500 sds/ac
Acres	30.0
Treatments	4
Reps	4
Treatment Width	40 ft.
Tillage	Conventional
Herbicide	Round-Up
Pesticide	Headline AMP
Previous Crop	Soybeans
Row Spacing	30 in.
Soil Type	Crosby-Lewisburg silt loam (67%) Kokomo silty clay (33%)



Weather Summary

Total	APR	MAY	JUN	JUL	AUG	Total
Precip (in)	3.80	5.07	3.48	8.72	2.65	23.72
Cumulative GDDs	216.0	551.0	1124.0	1823.0	2404.0	2404.0

STUDY DESIGN

Planter downforce control systems have recently been adopted on a row by row basis. The ability to control the level of downforce on a planter row unit should provide optimal seeding depths during planting operations. A lack of downforce on the row unit could lead to uneven seeding depths.

Study Treatments	Applied Downforce (lbs)*	Emergence (%)
None	50	93.6
Light	200	95.7
Optimal	300	96.7
Heavy	450	95.5

*Measured as total load applied on the row unit

JD 8320R with a 16-row 1775NT JD planter equipped with the JD downforce control system.

OBSERVATIONS

The field in this project produced record yields, averaging over 226 bu/ac. Ample nutrients, water, and lack of yield limiting factors contributed to the high production. Minimal variability between treatments was observed, with timely rainfall helping the grain-filling growth stages rally out of any deficits.

Emergence

Expected emergence results were observed to be greatest for the “optimal” DF level having greater emergence percentages. Lack of downforce control resulted in a 3% decrease in emergence. Growth stage uniformity increased with downforce level from 50-300 lbs. then declined with 450 lb. level.

Very uniform emergence observed for 300 lb. DF level.

Observing root structures for various treatments.

Tools of the Trade

John Deere Individual Row Hydraulic Downforce

IRHD works as a closed-loop downforce system that reacts on an individual row basis to changing soil conditions, supporting increased ground contact, which can lead to improved seed depth consistency.

Compaction

Penetrometer readings were taken, and root structures were observed for all treatments. No significant compaction effects were observed from over application of downforce on the row unit.

SUMMARY

- Lack of proper downforce levels resulted in a 3% decrease in emergence.
- It was observed that the optimal downforce level provided the most uniform seedbed.
- Optimal (300 lb DF) level yielded the highest out of all 4 treatments, but this was not significant.

KEY PARTNERS

The OSU Precision Ag team would like to thank Farm Manager Nate Douridas, and the Molly Caren Agricultural Center staff for their assistance with this study.

PROJECT CONTACT

For inquiries about this project, contact Trey Colley, Graduate Research Assistant, Department of Food, Agricultural and Biological Engineering (Colley.65@osu.edu).

Treatments	Downforce (lbs)	Moisture (%)	Yield (bu/ac)
None	50	19.6	228 a
Light	200	19.7	230 a
Optimal	300	19.7	231 a
Heavy	450	19.7	230 a

Treatment Means with the same letter are not significantly different according to Fisher’s Protected Least Significant Differences (LSD) test at alpha = 0.1.

Wing Downforce

OBJECTIVE

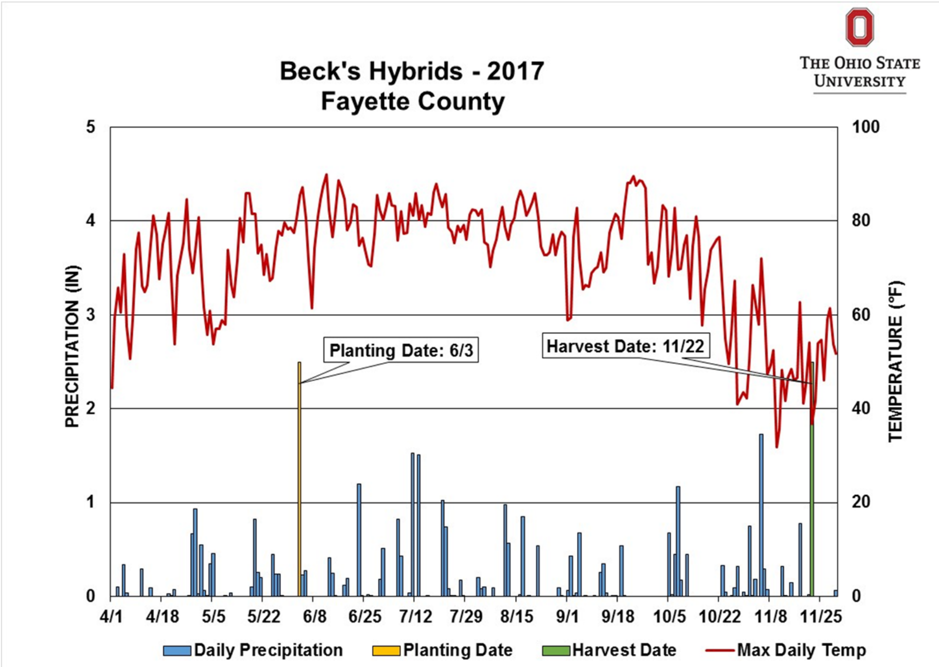
Understand the potential agronomic benefits of wing downforce technology.

Beck's Hybrids

Fayette County

STUDY INFORMATION

Planting Date	6/3/17
Harvest Date	11/22/17
Variety	Beck's 6076V2P
Population	34,000 sds/ac
Acres	129.0
Treatments	4
Reps	7
Treatment Width	40 ft.
Tillage	Cultivator
Herbicide	Round-Up
Pesticide	N/A
Previous Crop	Soybeans
Row Width	30 in.
Soil Type	Crosby silt loam (52%) Celina silt loam (23%)



Weather Summary

Total	APR	MAY	JUN	JUL	AUG	Total
Precip (in)	3.39	5.52	4.30	7.44	2.62	23.27
Cumulative GDDs	248.3	603.3	1211.9	1917.1	2506.3	2506.3

STUDY DESIGN

Wing downforce control systems have recently been encouraged for modern planters as a means to prevent planter wings from rising during the planting operation and reduce the weight of the center section of the planter. Potentially, as the planter moves through the field, the wings of the planter can lift, resulting in less than optimal performance of the outside rows. Additionally, the weight from the center section of the planter can cause pinch row compaction on the center 6 rows decreasing yield. For this study, a 16-row Case IH 2150 planter was used to investigate the effects of wing downforce technology.

No yield limiting factors were observed throughout the growing season.

Planting was conducted with a wing downforce control system on a Case IH 2150 16-row planter and a Case IH Magnum 380 row crop tractor.

OBSERVATIONS

During planting, the wing downforce control system was observed to keep the planter wings level. Although there were no directly observed stand count differences, the row units refrained from ‘floating’ in the field.

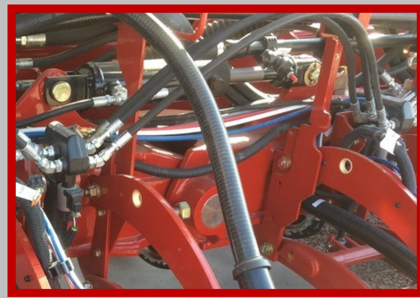
The Precision planting POGO stick and Research Pogo App was used to collect emergence and stand count data during the growing season. A summary presented in the table below:

Tools of the Trade

Case IH Wing Downforce Control System

Hydraulic Downforce Control

The Case IH Wing Downforce Control System allows for on the go wing downforce control. This system provides optimal conditions for row units.



Side-view of row unit located on the outside of the wing.

Wing downforce could potentially be beneficial in a non-uniform planting environment.

SUMMARY

- No significant differences in stand count were observed across treatments.
- Statistical differences in yield was observed. The wing downforce level settings 0 lbs and 300 lbs are different than the800 lbs.

KEY PARTNERS

The OSU Precision Ag team would like to thank the Beck’s Hybrids for their assistance in growing season applications, and harvest logistics. Precision Planting supplies the POGO sticks for our team to collect the performance data throughout the growing season. CNH Industrial University loan program supplied the planting, tillage and harvesting equipment through Evolution Ag and Wellington Implement.

PROJECT CONTACT

For inquiries about this project, contact Andrew Klopfenstein, Senior Research Associate Engineer, Department of Food, Agricultural and Biological Engineering (Klopfenstein.34@osu.edu).

Treatments (lbs)	Avg. Emergence (sds/ac)	Yield (bu/ac)
0	32,850	230 a
300	32,500	229 a
600	32,860	227 ab
800	32,435	225 b
Treatment Means with the same letter are not significantly different according to Fisher’s Protected Least Significant Differences (LSD) test at alpha = 0.1.		LSD: 3.38 CV: 1.60%

2017 World Record Attempt

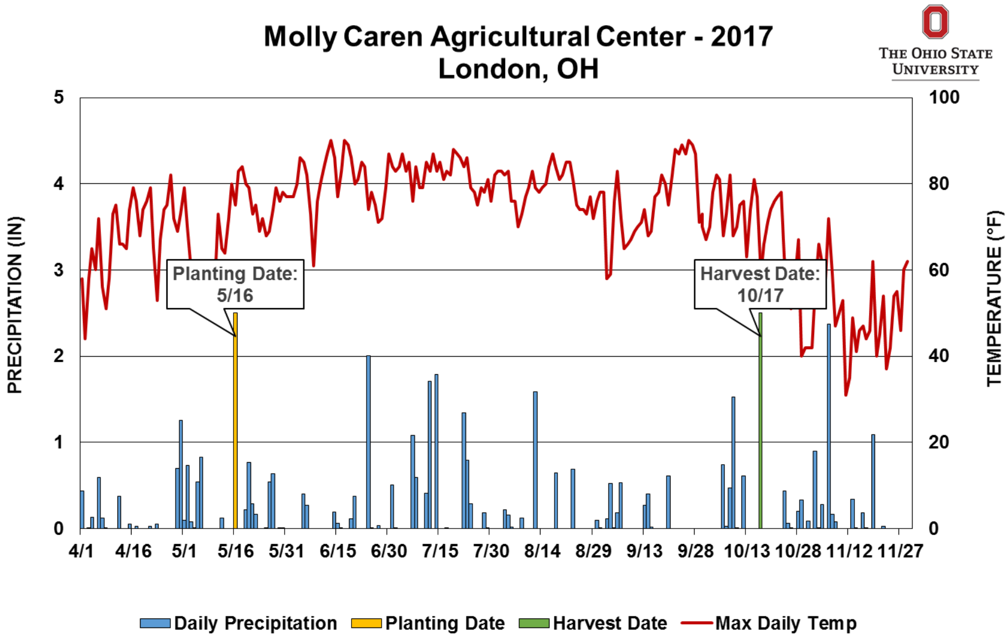
Molly Caren
Agricultural Center
Madison County

OBJECTIVE

Understand how data generated by precision agriculture technologies can be used to provide value to farmers.

STUDY INFORMATION

Planting Date	5/16/17
Harvest Date	10/17/17
Variety	USA1145RR
Population	34,500 sds/ac
Acres	100.0
Row Width	30 in.
Soil Type	Crosby-Lewisburg silt loam (67%) Kokomo silty clay (33%)

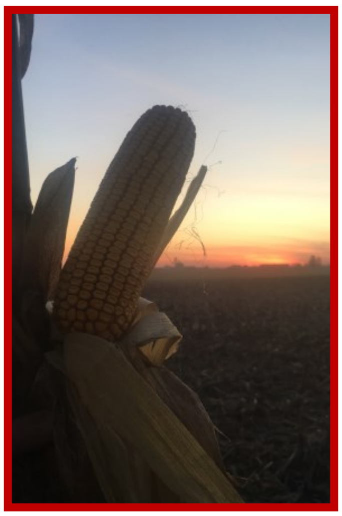


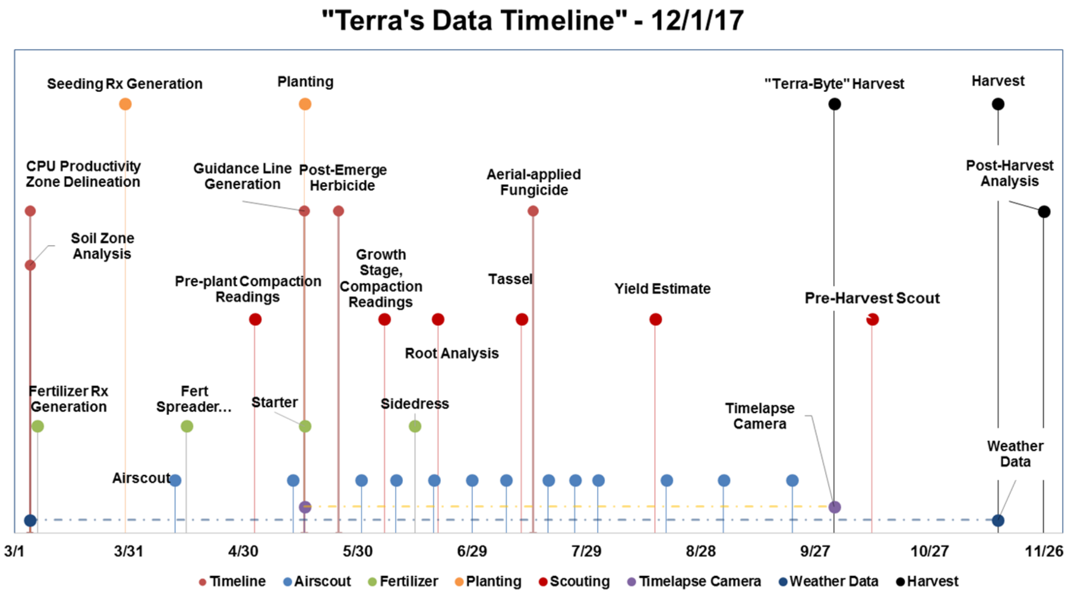
Categories of Data Collected

1. Basic Grower/Farm/Field
2. Operational
3. Agronomic
4. Field Management
5. Observational

Weather Summary

Total	APR	MAY	JUN	JUL	AUG	Total
Precip (in)	3.80	5.07	3.48	8.72	2.65	23.72
Cumulative GDDs	216.0	551.0	1124.0	1823.0	2404.0	2404.0





STUDY DESIGN

In order to help farmer's in Ohio understand which Precision Ag technologies best fit their operation, the Ohio State Precision Ag Team decided to implement all the precision ag technologies at our disposal on a single plant. This was conducted on a large-scale commercial farming operation in order to provide a realistic implementation perspective. The plant was nick-named "Terra-Byte" and it's growth was monitored with various digital tools and services.

OBSERVATIONS

All of the digital agriculture technologies and services were found to have some type of value. Data layers we determined particularly useful for the production of this field were:

- Operational As-applied Mapping
- Aerial Imagery
- As-planted
- 1/2 acre grid soil sampling
- Seeding Rx's
- Base Scouting

"Terra-Byte" plant marked by the Ohio State flag off of I-70 at Farm Science Review.

Tools of the Trade

SEEK Thermal Camera

Thermal Imaging System

The SEEK Thermal Camera uses a thermal sensor to detect changes in heat surrounding an object. We used it to observe stress levels in "Terra-byte", but luckily found none. This camera is compatible with iPhone or Android.

SUMMARY

- Many digital tools and services were evaluated for agronomic value, ease of use, and many other attributes (details can be found online).
- 18.5 GB were recorded for "Terra-Byte", more than any other corn plant in the world!

KEY PARTNERS

The OSU Precision Ag team would like to thank Farm Manager Nate Douridas, and the Molly Caren Agricultural Center staff for their assistance with this study.

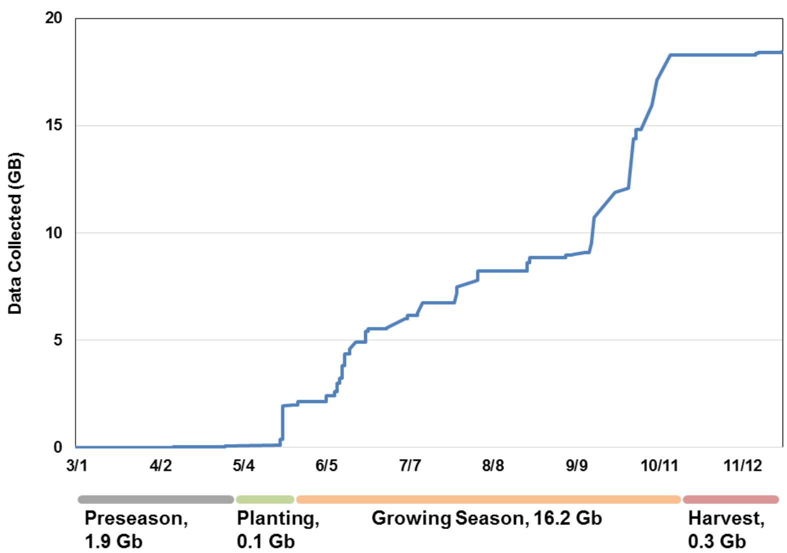
PROJECT CONTACT

For inquiries about this project, contact Trey Colley, Graduate Research Assistant, Department of Food, Agricultural and Biological Engineering (Colley.65@osu.edu).

For more information, please visit:

http://go.osu.edu/Terra or scan QR Code below.

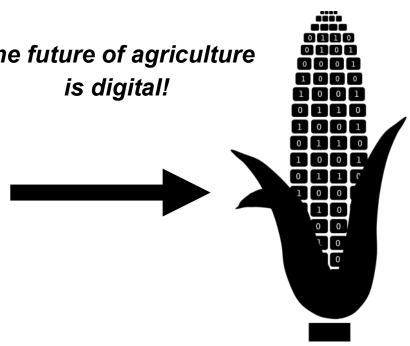
Data Collection over the Growing Season



"Terra-Byte" Final Statistics

- 18.5 Gb
- 2,475 Individual Files
- 28.1 Mb per Kernel

The future of agriculture is digital!



Multi-Hybrid Corn—OSU Logo

OBJECTIVE

Execute a multi-hybrid seeding prescription to demonstrate advancements in modern precision seeding technologies.

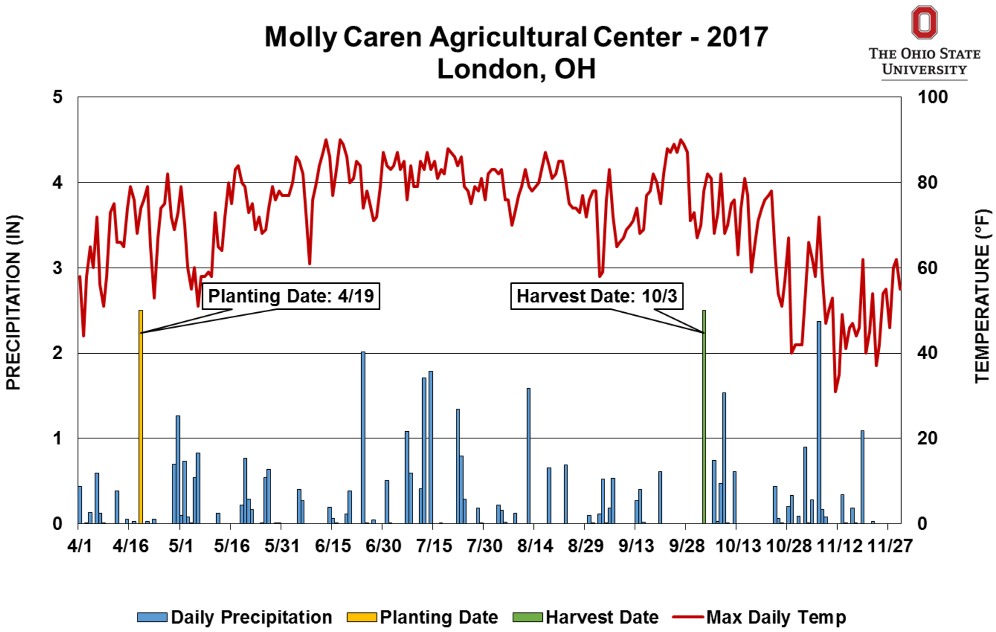
Molly Caren

Agricultural Center

Madison County

STUDY INFORMATION

Planting Date	4/19/17
Harvest Date	10/3/17
Variety	(1) LG5499STX RIB (2) P1184AM
Population	34,300 sds/ac
Acres	46.4
Treatment Width	40 ft.
Tillage	Conventional
Previous Crop	Soybeans
Row Width	30 in.
Soil Type	Crosby-Lewisburg silt loam (27%) Westland silty clay loam (52%) Eldean silt loam (21%)



Weather Summary

Total	APR	MAY	JUN	JUL	AUG	Total
Precip (in)	3.80	5.07	3.48	8.72	2.65	23.72
Cumulative GDDs	216.0	551.0	1124.0	1823.0	2404.0	2404.0

STUDY DESIGN

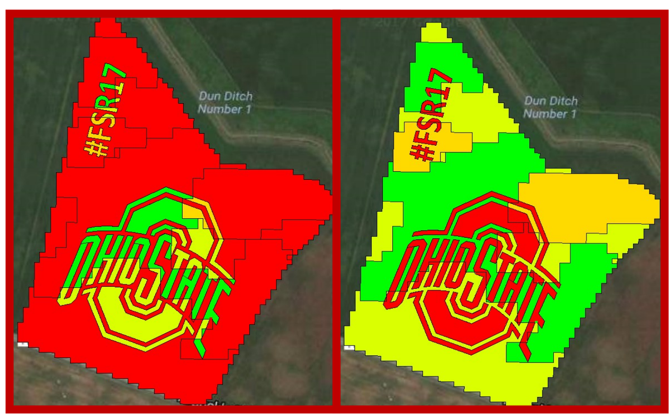
Multi-hybrid planting technologies have provided an opportunity for producers to place different varieties of corn within the same planter pass. This can provide benefits by placing aggressive offensive hybrids in highly productive portions of the field, while simultaneously placing more conservative, defensive hybrids in poorly productive areas of the field. In an effort to demonstrate these technologies, the Ohio State Precision Ag Team planted two hybrids in a field on the Molly Caren Agricultural Center site.

"Block O"

2015

"Brutus"

2016



Two seeding prescriptions were used at the time of planting; hybrid Rx and population Rx.

OBSERVATIONS

This is the third consecutive year that the Ohio State in-field multi-hybrid design has been performed. This year was the most complex logo design yet, and the spring proved challenging to execute the planting operation. However, due to great work by our field operations team the logo was a huge success, earning praise from Ohio State officials, and attention from various farm media outlets.

Prescription Generation

The SMS Advanced software package was used to generate a seeding prescription for each hybrid (two prescriptions, one for each hybrid are needed). These prescriptions were then executed through the Precision Planting 20/20 SeedSense Display.

Hybrid Selection

The hybrids selected for this study were chosen based off of the maturity dates for each hybrid. One hybrid reached the dry-down stage quicker, revealing the in-field design.

Considerations

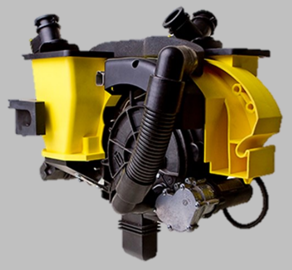
Careful execution of the seeding prescription is crucial to ensure the logo is properly displayed in the field. Here are some helpful hints for executing the Rx:

1. Ensure GPS offsets, and meter calibrations are accurate.
2. Proper time delay settings ensure accurate transition between hybrids.
3. Maintain consistent speed across the field.

Tools of the Trade

vSet Select Seed Meter

Multi-hybrid Placement Device



The vSet Select Meter from Precision Planting allows for precise placement of two hybrids with outstanding accuracy. In this study, the meter was used to plant two hybrids at a variable rate based on our seeding prescription.

SUMMARY

- The multi-hybrid design was properly executed for the 3rd consecutive year.
- Stay tuned for the 2018 multi-hybrid design!

KEY PARTNERS

The OSU Precision Ag team would like to thank Nate Douridas, Farm Manager of the Molly Caren Agricultural Center, and the rest of the Molly Caren Agricultural Center Staff for their contributions to this project.

PROJECT CONTACT

For inquiries about this project, contact Andrew Klopfenstein—Senior Research Associate Engineer, Department of Food, Agricultural and Biological Engineering (klopfenstein.34@osu.edu).

The planting prescription used to execute this logo was generated using the SMS Advanced software package (left), the multi-hybrid logo image was taken by plane during the dry down stage.

High Speed Planting

OBJECTIVE

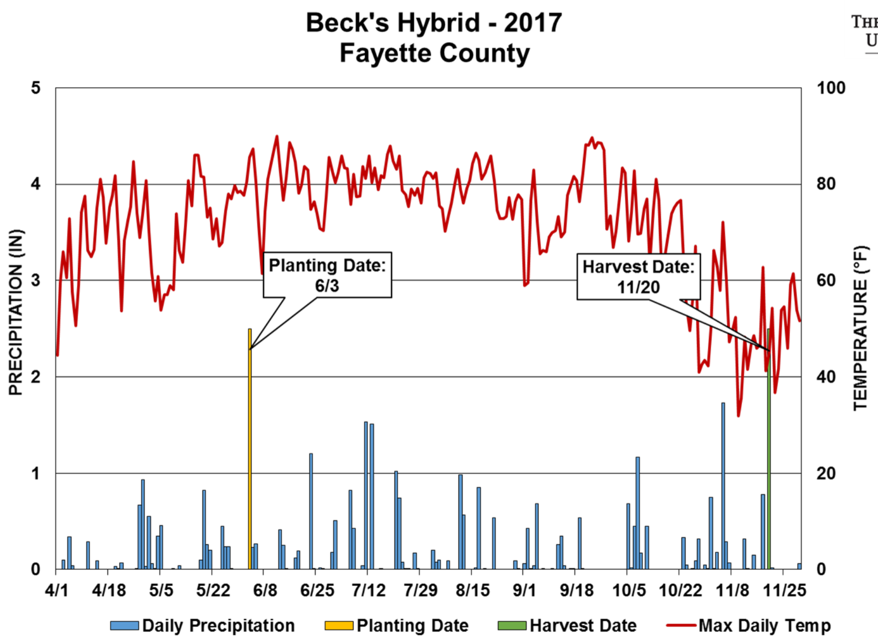
Understand planter speed and its effects on emergence and corn yield.

Beck's Hybrids

Fayette County

STUDY INFORMATION

Planting Date	6/3/17
Harvest Date	11/20/17
Variety	Beck's 6076V2P
Population	34,000 sds/ac
Acres	70.0
Treatments	5
Reps	7
Treatment Width	40 ft.
Tillage	Cultivator
Herbicide	Round-Up
Pesticide	N/A
Previous Crop	Soybeans
Row Width	30 in.
Soil Type	Crosby silt loam (52%) Celina silt loam (23%)



Weather Summary

Total	APR	MAY	JUN	JUL	AUG	Total
Precip (in)	3.39	5.52	4.30	7.44	2.62	23.27
Cumulative GDDs	248.3	603.3	1211.9	1917.1	2506.3	2506.3

STUDY DESIGN

High speed planter systems have recently been adopted for modern planters. Some research has been done on the effect of speed with these new technologies on emergence and yield, but little research in Ohio. This study evaluates five speeds of planting in central Ohio and their effects on yield and emergence.

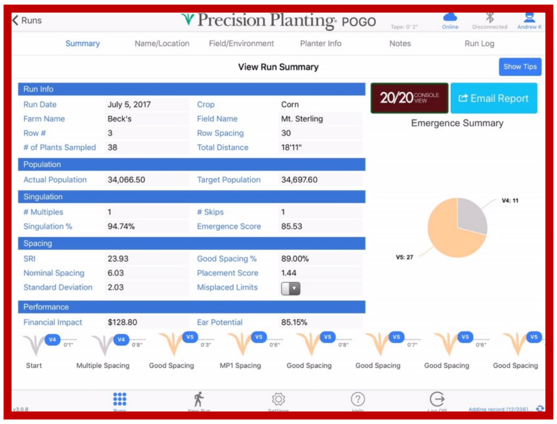
Study Treatments (mph)	Actual Avg. Speed (mph)	Theoretical Capacity (ac/hr)	Adjusted Field Capacity (ac/hr)
5.0	4.9	24	19
7.5	7.4	36	29
10.0	9.8	48	38
12.5	12.1	60	48
17.0	15.0	82	58

Planting was conducted with a Case IH 2150 16-row planter with Precision Planting high speed technology components.

OBSERVATIONS

Throughout the year, plant growth was monitored for any potential treatment differences. No yield limiting factors were observed.

A Case IH 500 Quadtrac pulled the 16-row Case IH 2150 planter.



Emergence

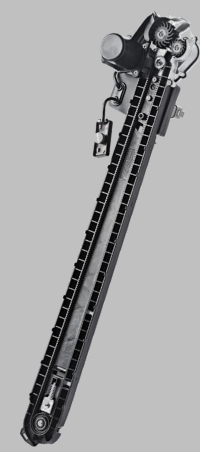
Precision planting POGO stick and Research Pogo App was used to collect emergence and stand count data during the growing season. Expected emergence results were observed between speeds, with 5.0 mph having higher emergence (%) over the other treatments.

Tools of the Trade

Precision Planting SpeedTube

Electric row by row seed delivery

SpeedTube allows the row unit place seeds at precisely the right spacing by matching planting speed with near 0 velocity seed drop. Pairing SpeedTube with the 20/20 display and vSet electric drive allows the operator to observe and adjust row unit parameters in real-time.



SUMMARY

- No statistical difference in yields were observed between the different planting speeds.
- Planting speed did not effect the uniformity of emergence at different speeds.

KEY PARTNERS

The OSU Precision Ag team would like to thank the Beck's Hybrids for their assistance in growing season applications, and harvest logistics. Precision Planting supplies the POGO sticks for our team to collect the performance data throughout the growing season. CNH Industrial University loan program supplied the planting, tillage and harvesting equipment through Evolution Ag and Wellington Implement. Additionally, we want to thank Unverferth Manufacturing for supplying equipment to help with this project.

PROJECT CONTACT

For inquiries about this project, contact Andrew Klopfenstein, Senior Research Associate Engineer, Department of Food, Agricultural and Biological Engineering (Klopfenstein.34@osu.edu).

Treatments (mph)	Avg. Emergence (%)	Avg. Singulation (%)	Spacing Std. Dev. (in.)	Spacing CV (%)	Yield (bu/ac)
5.0	95.8%	96.6	1.8	0.29	210 a
7.5	94.9%	96.2	1.9	0.31	210 a
10.0	95.1%	95.6	2.0	0.33	210 a
12.5	94.9%	95.8	2.0	0.32	207 a
17.0	93.9%	94.1	2.3	0.37	208 a

Treatment Means with the same letter are not significantly different according to Fisher's Protected Least Significant Differences (LSD) test at alpha = 0.1.

LSD: 9.82
CV: 5.12%

OBJECTIVE

Determine the effects of nitrogen timing on corn yield and profitability.

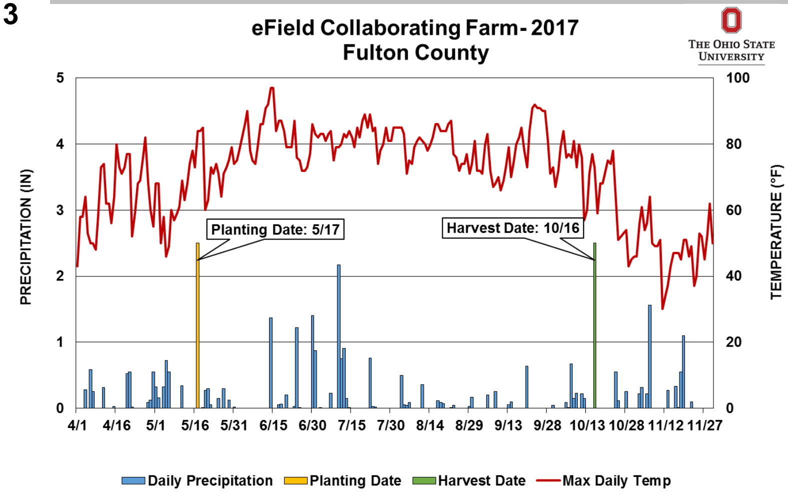
eFields Collaborating Farm

OSU Extension

Fulton County

STUDY INFORMATION

	Fulton Co. 1	Fulton Co. 2	Fulton Co. 3
Planting Date	5/17/2017	5/16/2017	5/18/2017
Harvest Date	10/16/2017	10/19/2017	10/16/2017
Variety	DKC 5520	P0843 AM	P0825 AM
Population	34,000	33,000	33,000
Acres	13.0	55.0	40.0
Treatments	4	4	4
Reps	3	4	3
Treatment Width	30-60 ft.	60 ft.	60 ft.
Tillage	Fall Chisel	Stale Seed Bed	Spring cultivate
Herbicide	Triple Flex, Atrazine, Roundup	Triple Flex, Atrazine, Sharpen	Bicep II Magnum, Roundup
Nitrogen At Plant (lbsN/ac)	90	70	70
Previous Crop	Soybeans	Soybeans	Soybeans
Row Width	30 in.	30 in.	30 in.
Soil Type	Lenawee silty clay loam Fulton silty clay loam	Mermill loam Haskins loam	Hoytville loam Mermill loam



Weather Summary

Total	APR	MAY	JUN	JUL	AUG	Total
Precip (in)	3.30	3.63	4.34	5.91	1.56	18.74
Cumulative GDDs	145.0	420.0	1020.0	1714.0	2292.0	2292.0

STUDY DESIGN

High-clearance equipment has allowed producers to stretch the nitrogen application window in corn. Since 2016, three on-farm collaborators have committed to multi-year late season nitrogen trials in Fulton County. In each trial, the check treatment is the farmer's normal practice of applying all remaining nitrogen at sidedress or approximately 5-leaf (V5) corn. Fewer source and equipment options are available for late season applications. As such, the check treatments in these studies may have different source or placement characteristics than the late season treatments. Finally, in 2017, several 'reduced rate' treatments were tried as corn is generally more efficient with nitrogen applied later in season.

Late season N application on ten-leaf (V10) corn.

Results—Fulton #1		2017 Data						2016 Data
Treatments	Placement	Rate (total N/ac)	Source	CSNT (ppm)	Yield (bu/ac)	Yield Diff (bu/ac)	NUE (lbs N/bu)	Yield (bu/ac)
Check @ V5	Coulter/Knife	210	28% UAN	58	233 a	-	.90	219 a
Late N @ V12	Drops	210	28% UAN	449	235 a	+2	.89	219 a
Split @ V5 & V12	Both	210	28% UAN	1,375	239 a	+6	.88	222 a
Late N @ V12 (reduced)	Drops	168	28% UAN	173	220 b	-13	.76	N/A

Treatments with the same letter are not significantly different according to Fisher's Protected Least Significant Differences (LSD) test at alpha = 0.1.

SUMMARY #1

In season application equipment allows for a longer nitrogen application window with no impact on yield when comparing similar nitrogen rates. Split in-season applications have not shown significant yield gains in this study.

Results—Fulton #2		2017 Data						2016 Data
Treatments	Placement	Rate (total N/ac)	Source	CSNT (ppm)	Yield (bu/ac)	Yield Diff (bu/ac)	NUE (lbs N/bu)	Yield (bu/ac)
Check @ V5	Y-Drops ®	210	28% UAN	831	223 a	-	.94	174 a
Late N @ V10	Y-Drops ®	210	28% UAN	1,048	218 a	-5	.96	176 a
Late N @ V10 (reduced)	Y-Drops ®	168	28% UAN	57	218 a	-5	.77	176 a
Late N @ V10 (reduced)	Y-Drops ®	126	28% UAN	20	207 b	-16	.61	N/A

Treatments with the same letter are not significantly different according to Fisher's Protected Least Significant Differences (LSD) test at alpha = 0.1.

SUMMARY #2

Late season nitrogen application at reduced rates can produce statistically similar yields at reduced input cost. Additional study is needed to better refine reduced rates and environmental conditions that drive late N rates.

Results—Fulton #3		2017 Data						2016 Data
Treatments	Placement	Rate (total N/ac)	Source	CSNT (ppm)	Yield (bu/ac)	Yield Diff (bu/ac)	NUE (lbs N/bu)	Yield (bu/ac)
Check @ V5	Gas Injection	210	Anhydrous	458	209 a	-	1.0	212 a
Late N @ V12	Drops	210	28%	972	212 a	+4	.99	211 a
Split @ V5 & V12	Both	210	Both	1,633	214 a	+6	.98	214 a
Late N @ V12 (reduced)	Drops	168	28%	148	211 a	+3	.80	N/A

Treatments with the same letter are not significantly different according to Fisher's Protected Least Significant Differences (LSD) test at alpha = 0.1.

SUMMARY #3

Corn yields showed no difference when comparing late season application of 28% UAN and sidedress anhydrous ammonia when applied at similar N rates . Also, no significant yield loss was realized at a reduced rate of 168 lbs total N per acre in this study.

KEY PARTNERS

The project contact expresses appreciation to on-farm collaborators J & J Ag, VonSeggern Farms and Larry Richer. Thanks to the Ohio Corn Checkoff Board and OARDC Fertility Lab for supporting this research. Thanks also to Ross Andre, Ben Eggers and Kaitlin Ruetz, OSUE interns for data collection and processing.

PROJECT CONTACT

For inquiries about this project, contact Eric Richer, Extension Educator, Agriculture and Natural Resources, Ohio State University Extension– Fulton County (richer.5@osu.edu).

OBJECTIVE

Investigate the effectiveness of nitrogen application when applied during the late-season (post V10) timeframe.

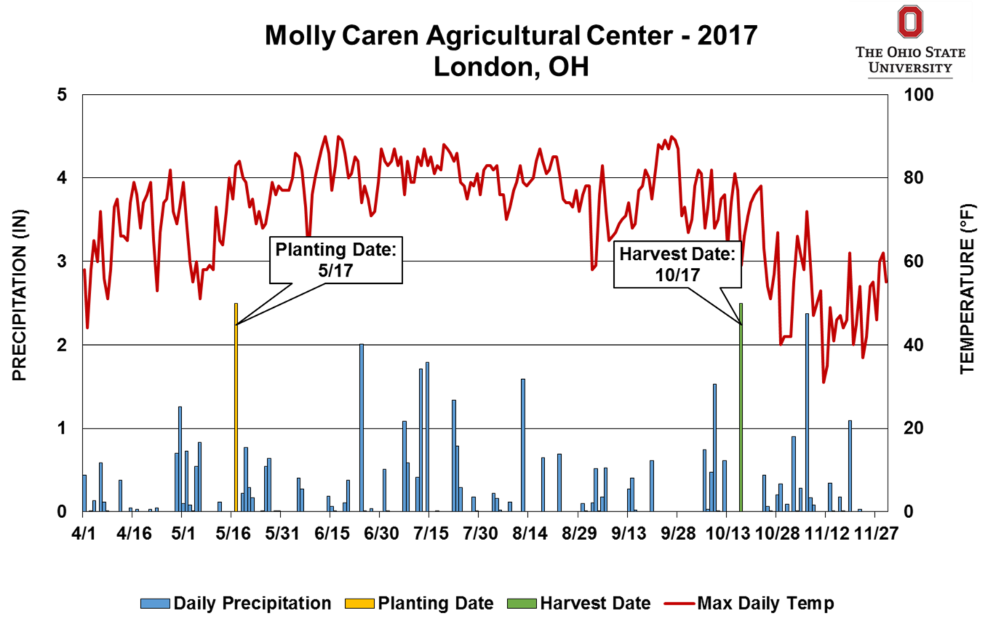
Molly Caren

Agricultural Center

Madison County

STUDY INFORMATION

Planting Date	05/17/2017
Harvest Date	10/17/2017
Variety	DKC61-54RIB
Population	Treatments
Acres	35.7
Treatments	3
Reps	7
Treatment Width	40 ft.
Tillage	Conventional
Herbicide	N/A
Pesticide	N/A
Previous Crop	Soybeans
Row Spacing	30 in.
Soil Type	Kokomo silty clay loam (54%) Crosby-Lewisburg silt loam (46%)



Weather Summary

Total	APR	MAY	JUN	JUL	AUG	Total
Precip (in)	3.80	5.07	3.48	8.72	2.65	23.72
Cumulative GDDs	216.0	551.0	1124.0	1823.0	2404.0	2404.0

STUDY DESIGN

This study tested the efficacy of late-season nitrogen application. See below treatments for applied units of N throughout the growing season. 28% UAN was the nitrogen source used for late-season applications. For this study, three separate applications of nitrogen were used as seen below:

Treatments (gpa)	Total Applied N (lbs N/ac)	Pre-Plant Anhydrous (lbs N/ac)	Planter 2x2 (lbs N/ac)	Late Season App—V10 (lbs N/ac)
Check	180	140	40	-
LSN 15	180	100	40	40
LSN 20	200	100	40	60

OBSERVATIONS

For this study, the growing season provided multiple challenges including a partial re-plant after heavy May rains. All other field conditions were observed to be non–yield limiting on the crop.

Late-season nitrogen applications were conducted with a New Holland SP 300F sprayer.

Aerial Image taken on 7/26/17 illustrating minimal differences between treatments.

Tools of the Trade

AirScout Aerial Imagery

Manned aircraft in-season flights

AirScout's web-interface and iPad based App allows for directive in-season scouting and crop vigor assessments. For all studies at the Molly Caren Agricultural Center were flown 13 times throughout the growing season.

AirScout®

The Proactive Crop Management Tool™

"N DECISION"

Early in July, it was determined to use flat rate late-season N applications based off of crop scouting, aerial imagery, and field history. It was also determined that two rates, one higher and one reduced rate, would be implemented to evaluate N-use efficiency for 2017.

SUMMARY

- Based on this study, a statistical difference was found between the check and the 15 GPA late season application.
- No statistical difference was found between the check and the 20 GPA late season application.

PROJECT CONTACT

For inquiries about this project, contact Andrew Klopfenstein, Senior Research Associate Engineer, Department of Food, Agricultural and Biological Engineering (Klopfenstein.34@osu.edu).

Treatments (gpa)	Yield (bu/ac)
Check	233 a
LSN 15 GPA	223 b
LSN 20 GPA	230 a
Treatment Means with the same letter are not significantly different according to Fisher's Protected Least Significant Differences (LSD) test at alpha = 0.1.	LSD: 4.71 CV: 2.16%

Late-Season Nitrogen

N - P- K

OBJECTIVE

Investigate the effectiveness of nitrogen application when applied during the late-season (post V10) timeframe.

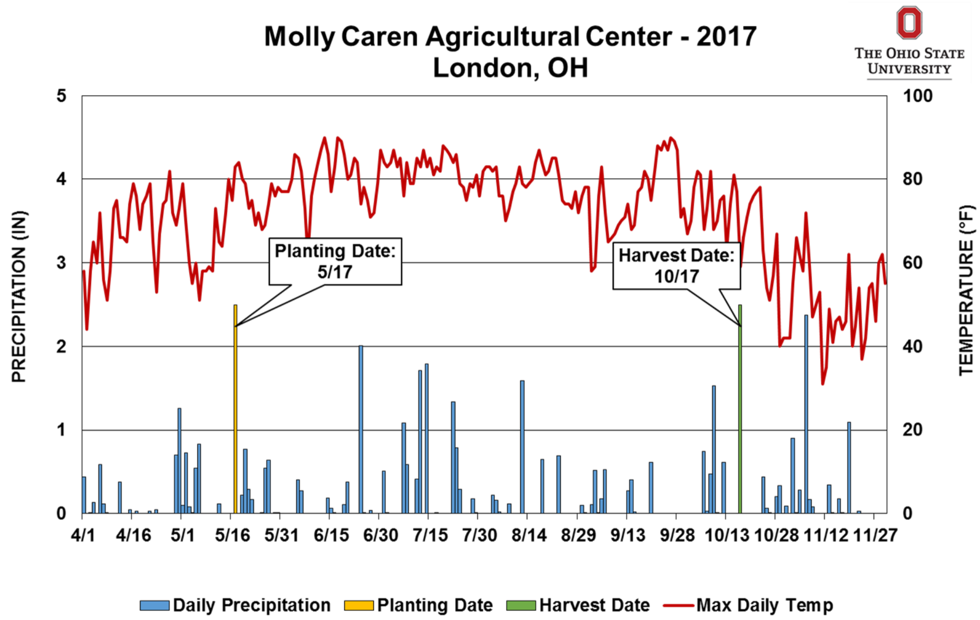
Molly Caren

Agricultural Center

Madison County

STUDY INFORMATION

Planting Date	5/17/2017
Harvest Date	10/17/2017
Variety	DKC61-54RIB
Population	Treatments
Acres	22.7
Treatments	3
Reps	4
Treatment Width	40 ft.
Tillage	Conventional
Herbicide	N/A
Pesticide	N/A
Previous Crop	Soybeans
Row Spacing	30 in.
Soil Type	Kokomo silty clay loam (21%) Crosby-Lewisburg silt loam (79%)



Weather Summary

Total	APR	MAY	JUN	JUL	AUG	Total
Precip (in)	3.80	5.07	3.48	8.72	2.65	23.72
Cumulative GDDs	216.0	551.0	1124.0	1823.0	2404.0	2404.0

STUDY DESIGN

This study tested the efficacy of late season nitrogen application. See below treatments for applied units of N throughout the growing season. 28% UAN was the nitrogen source used for late season applications. For this study, three separate applications of nitrogen were used as seen below:

Treatments (gpa)	Total Applied N (lbs N/ac)	Pre-Plant Anhydrous (lbs N/ac)	Planter 2x2 (lbs N/ac)	Late Season App—V10 (lbs N/ac)
Check	180	140	40	-
LSN 15	180	100	40	40
LSN 20	200	100	40	60

OBSERVATIONS

For this study, the growing season provided multiple challenges including a partial re-plant after heavy May rains. All other field conditions were observed to be non-yield limiting on the crop.

Late season nitrogen applications were conducted with a New Holland SP 300F sprayer.

Aerial Image taken on 7/26/17 with the exception of the zero strips, minimal treatment differences were observed.

Tools of the Trade

Precision Planting YieldSense

Precision Yield Monitor

The Precision Planting YieldSense yield monitor allowed for accurate measurement of strip treatment yields during the harvest season.

"N DECISION"

Early in July, it was determined to use flat rate late-season N applications based off of crop scouting, aerial imagery, and field history. It was also determined that two rates, one higher and one reduced rate, would be implemented to evaluate N-use efficiency for 2017.

SUMMARY

- Based on this study, a statistical difference was found between the check and both the 15 and 20 GPA late season application.

PROJECT CONTACT

For inquiries about this project, contact Andrew Klopfenstein, Senior Research Associate Engineer, Department of Food, Agricultural and Biological Engineering (Klopfenstein.34@osu.edu).

Treatments (gpa)	Yield (bu/ac)
Check	247 a
LSN 15	240 b
LSN 20	242 ab
Treatment Means with the same letter are not significantly different according to Fisher's Protected Least	LSD: 6.61 CV: 1.98%

Late-Season Nitrogen

N - P - K

eFields Collaborating Farm

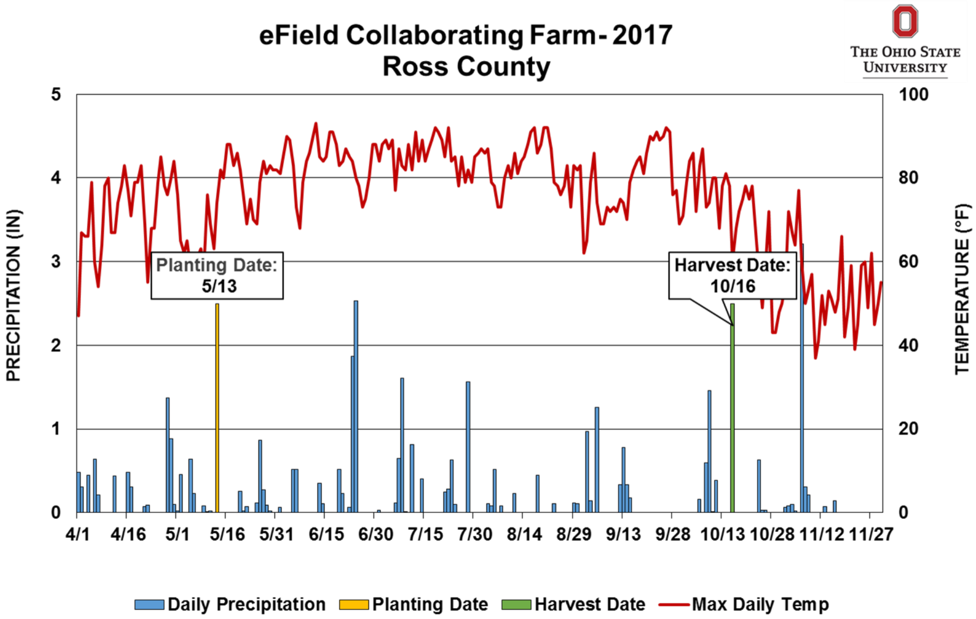
Ross County

OBJECTIVE

Investigate the effectiveness of nitrogen application when applied during the late-season (post V10) timeframe.

STUDY INFORMATION

Planting Date	5/13/2017
Harvest Date	10/16/2017
Variety	Beck's 5140 HR
Population	33,830
Acres	71.4
Treatments	2
Reps	4
Treatment Width	60 ft.
Tillage	No-Till
Herbicide	N/A
Pesticide	N/A
Previous Crop	Soybeans
Row Spacing	30 in.
Soil Type	Ockley loam (56%) Eldean loam (42%)



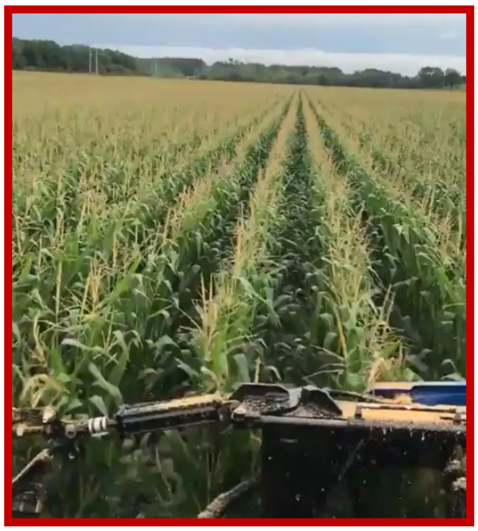
Weather Summary

Total	APR	MAY	JUN	JUL	AUG	Total
Precip (in)	5.83	3.18	6.77	6.45	1.81	24.04
Cumulative GDDs	325.0	767.0	1447.0	2241.0	2933.0	2933.0

STUDY DESIGN

This study evaluated a late season nitrogen application by providing a check against the growers standard practices. The late season application was applied during the VT growth stage. All treatments were provided with 20 total units of N at planting in the form of 25-0-0 starter fertilizer. Sidedress was completed with a top-dress application of Urea. 28% UAN was the nitrogen source used for the late season application. Timing and rates for the nitrogen applications are listed below:

Treatments	Side Dress (lbs N/ac)	Late Season Application (lbs N/ac)	Total Application (lbs N/ac)
Check	170	-	190
LSN	124	62	206



Late-season nitrogen applications were conducted around the VT growth stage.

OBSERVATIONS

Throughout the season, the crop was monitored for yield-limiting factors. Crop vigor was observed to be sufficient for both treatments throughout the season. Both treatments received the amount of total nitrogen shown in table on previous page and showed little signs of nutrient deficiencies.

The NutraBoss applicators used during this application are shown above. The resulting nitrogen is placed at the root of the plants.

Tools of the Trade

New Holland SP 300 F

High Clearance Sprayer

The New Holland SP 300 F Sprayer offers the opportunity to apply late-season N by boasting a high clearance platform. The front boom allows for greater visualization of the applicators during operation.

SUMMARY

- No statistical difference was found between the check and the 20 GPA late season application.

PROJECT CONTACT

For inquiries about this project, contact Andrew Klopfenstein, Senior Research Associate Engineer, Department of Food, Agricultural and Biological Engineering (Klopfenstein.34@osu.edu).

The New Holland SP 300 F sprayer was used to perform the late season applications for this study.

Treatments	Yield (bu/ac)
Check	224 a
LSN	224 a
Treatment Means with the same letter are not significantly different according to Fisher's Protected Least Significant Differences (LSD) test at alpha = 0.1.	LSD: 8.42 CV: 2.26%

Nitrogen Placement

N - P - K

OBJECTIVE

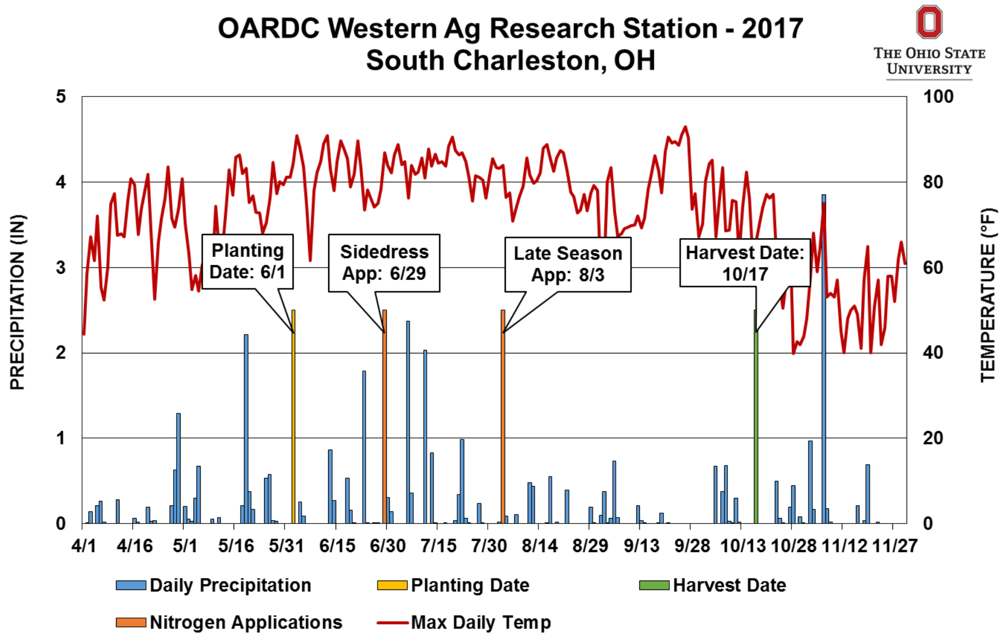
Investigate the best placement method for nitrogen when being applied during the late-season timeframe.

Western Agricultural Research Station

Clark County

STUDY INFORMATION

Planting Date	6/1/17
Harvest Date	10/17/17
Variety	P0825AM
Population	34,000 sds/ac
Acres	10.3
Treatments	4
Reps	4
Treatment Width	40 ft.
Tillage	No-Till
Herbicide	N/A
Pesticide	N/A
Previous Crop	Soybeans
Row Width	30 in.
Soil Type	Kokomo silty clay (48%) Strawn-Crosby



Weather Summary

Total	APR	MAY	JUN	JUL	AUG	Total
Precip (in)	3.39	5.52	4.30	7.44	2.62	23.27
Cumulative GDDs	235.0	571.0	1144.0	1900.0	2580.0	2580.0

STUDY DESIGN

This study evaluated various nitrogen placement systems. Each of these were capable of applying nitrogen in a late-season (Post V10) timeframe. All treatments were provided with 180 total units of N throughout the season. 28% UAN was the nitrogen source used for all applications. Timing and rates for the nitrogen applications are listed below:

Treatments	Side-Dress—V5 (lbs N/ac)	Late-Season Application—V10 (lbs N/ac)
Control	180	-
Y-drop	100	80
Drop Coulter	100	80
Center Drop	100	80

Late season nitrogen applications were conducted with a New Holland SP 300F sprayer.

OBSERVATIONS

During the growing season, ample rain during the early growth stages provided a boost to growing crops. After the sidedress nitrogen application, a visual boost in crop vigor was observed equally for both the control (180 lb N) and the other treatments (100 lb N). This confirmed that there were no limiting factors in the crop prior to the late season application. The three late season nitrogen placement methods are discussed in more detail below:

PLACEMENT SYSTEMS

Coulter-applied systems

(1) Sidedress coulter bar—a standard 40ft sidedress coulter bar was used to apply the 180 lb N/ac for the treatment control, as well as the base 100 lb N for all other treatments.

(2) Drop coulter bar—the drop coulter bar attached to a high clearance machine was used to apply 80 lbs N/ac during the late season application.

Surface-applied Systems

(3) Nutra-Boss Y-drops—the y-drop applicators were used to apply 80 lbs N/ac with a high clearance machine during the late season application.

(4) Center Drop Applicators—the y-drop applicators were modified in order to place 80 lb N/ac on the soil surface between corn rows.

Placement systems for the "Center Drop" (left) and "Y-drop" (right) treatments.

Tools of the Trade

New Holland N Coulter Bar

Late-Season N Placement

This 36 ft late-season N coulter bar enables producers to put Nitrogen below the surface of the soil even at late growth stages. In this study, we used the bar to apply 28% UAN at the V10 growth stage.

SUMMARY

- The y-drop and late-season coulter treatments produced statistically significant higher yields when compared with the control and center of row treatments.
- Conditions after the late-season application were persistently dry. This could explain the lack of nitrogen uptake for the surface applied systems.

KEY PARTNERS

The OSU Precision Ag team would like to thank the WARS staff for their assistance in growing season applications, and harvest logistics. Thanks to Pioneer for donating the seed.

PROJECT CONTACT

For inquiries about this project, contact John Fulton, Associate Professor, Department of Food, Agricultural and Biological Engineering (Fulton.20@osu.edu).

Treatments	Applied N (lbs/ac)	NUE (lbs N/ yield)	Moisture (%)	Yield (bu/ac)
Control (Sidedress)	180	0.83	22.0	216 a
Y-drop (Surface)	180	0.77	22.2	233 b
Coulter	180	0.78	22.1	232 b
Center of Row (Surface)	180	0.84	22.2	214 a
Treatment Means with the same letter are not significantly different according to Fisher's Protected Least Significant Differences (LSD) test at alpha = 0.1.				LSD: 7.86 CV: 2.71%

Pinch Row Corn

OBJECTIVE

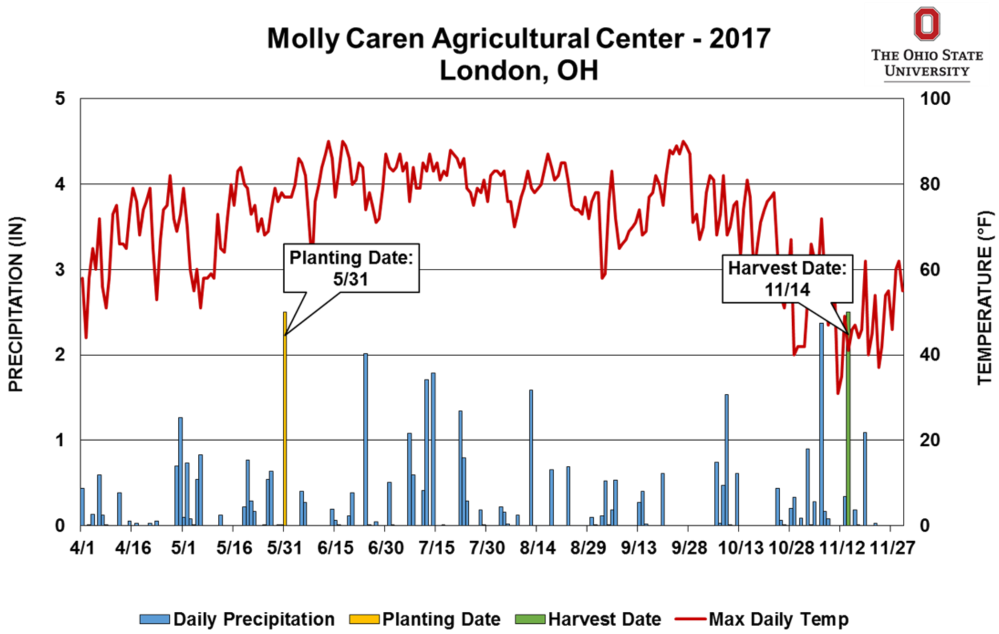
To evaluate if utilizing tracks on either the tractor or planter would reduce soil compaction in cropping rows influenced by field traffic.

Molly Caren Agricultural Center

Madison County

STUDY INFORMATION

Planting Date	5/31/17
Harvest Date	11/14/17
Variety	P1197AM
Population	34,000 sds/ac
Acres	130.0
Treatments	4
Reps	4
Treatment Width	40 ft.
Tillage	Conventional
Previous Crop	Soybeans
Row Width	30 in.
Soil Type	Crosby-Lewisburg silt loam (60%) Kokomo



Weather Summary

Total	APR	MAY	JUN	JUL	AUG	Total
Precip (in)	3.80	5.07	3.48	8.72	2.65	23.72
Cumulative GDDs	216.0	551.0	1124.0	1823.0	2404.0	2404.0

STUDY DESIGN

Tracked systems for tractors and planters have become popular options for attempting to reduce soil compaction in the rows adjacent to the paths of equipment travel. Multiple combinations of these tracked systems were evaluated and the tested variations in equipment set-up can be observed in the table below:

Treatments	Tractor	Planter
A	Wheeled	Wheeled
B	Wheeled	Tracked
C	Tracked	Wheeled
D	Tracked	Tracked

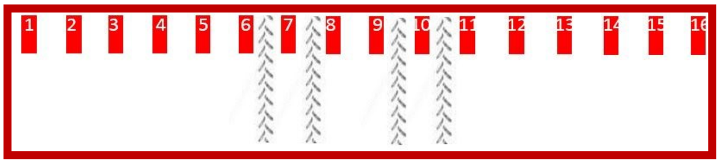
Equipment evaluated in this study: Tracked Tractor (top left), Wheeled Tractor (top right), Tracked Planter (bottom left), and Wheeled Planter (bottom right).

OBSERVATIONS

The Ohio State Precision Ag Team decided to investigate the effects of planter track systems and tractor track systems on corn.

Pinch Rows

Pinch row compaction is a common problem on every planter/tractor combination and especially bulk fill planters. Pinch rows are defined as any row that would be influenced due to compaction of the soil that falls within the tractor and/or implements footprint. To test this, there were 4 possible combinations including; wheeled tractor, tracked tractor, wheeled planter, tracked planter.



As seen above, Rows 6, 7, 8, 9, 10, 11 are all affected by this compaction either by the tractor, planter or both.

Growing Season

Throughout the growing season, the crop was monitored and no yield-limiting factors were observed. The field was scouted at multiple points throughout the growing season to investigate the effects of soil compaction on the "pinch rows" of the study.

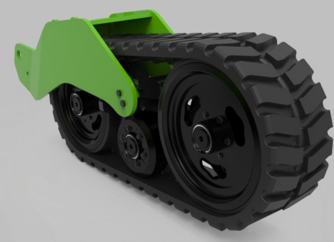
Precision Planting POGO Sticks were used to record both stand counts and growth staging throughout the year.

Tools of the Trade

Soucy S-TECH 012P

Planter Track System

The Soucy S-Tech Planter Track system provides the opportunity to reduce the amount of soil compaction while planting. These tracks increase the soil-track contact surface, distributing the planter weight more evenly.



Harvesting

In order to harvest the rows of interest, the 4 wing rows on either side of each treatment were harvested first. Next, the middle 8 rows of the pass were harvested to give a portrayal of the rows most impacted by excess machine traffic.

SUMMARY

- Rows 7 and 10 were observed to be impacted by the effects of compaction.
- No statistical differences were detected in the yields of either treatment.

KEY PARTNERS

Thanks to Nate Douridas, Farm Manager, and the rest of the Molly Caren Agricultural Center staff for their contributions to this study. We also would like to thank Camso for providing tracks for the tractor. Additionally, thanks to SoucyTrack for supplying planter tracks.

PROJECT CONTACT

For inquiries about this project, contact Andrew Klopfenstein—Senior Research Associate Engineer, Department of Food, Agricultural and Biological Engineering (klopfenstein.34@osu.edu).

Treatments	Yield - All Soil CPUs (bu/ac)	Yield - High Soil CPUs (bu/ac)	Yield - Medium Soil CPUs (bu/ac)	Yield - Low Soil CPUs (bu/ac)
Wheeled Tractor, Wheeled Planter	207 a	207 a	207 a	194 a
Wheeled Tractor, Tracked Planter	210 a	209 a	211 a	200 a
Tracked Tractor, Wheeled Planter	208 a	205 a	210 a	188 a
Tracked Tractor, Tracked Planter	210 a	214 a	208 a	197 a
Treatment Means with the same letter are not significantly different according to Fisher's Protected Least Significant Differences (LSD) test at alpha = 0.1.	LSD: 4.7 CV: 2.23%	LSD: 7.9 CV: 3.75%	LSD: 4.1 CV: 1.95%	LSD: n/a CV: n/a

Pinch Row Corn

Beck's Hybrids

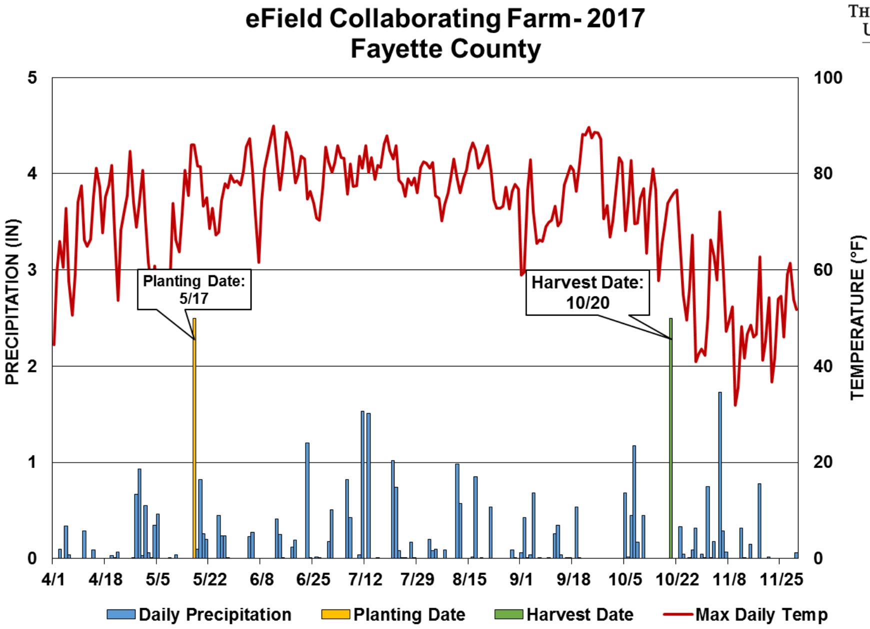
Fayette County

OBJECTIVE

Evaluate if utilizing tracks on either the tractor or planter would reduce soil compaction in cropping rows influenced by field traffic.

STUDY INFORMATION

Planting Date	5/1717
Harvest Date	10/20/17
Variety	Beck's 6076V2P
Population	34,000 sds/ac
Acres	129.0
Treatments	4
Reps	7
Treatment Width	40 ft.
Tillage	Cultivator
Previous Crop	Round-Up
Row Width	N/A
Soil Type	Soybeans
Row Spacing	30 in.
Soil Types	Crosby silt loam (52%) Celina silt loam (23%)



Weather Summary

Total	APR	MAY	JUN	JUL	AUG	Total
Precip (in)	3.39	5.52	4.30	7.44	2.62	23.27
Cumulative GDDs	248.3	603.3	1211.9	1917.1	2506.3	2506.3

STUDY DESIGN

Tracked systems for both tractors and planters have become popular options for attempting to reduce soil compaction in the rows passed on either side by implement or vehicle travel. Multiple combinations of these tracked systems were evaluated and the tested variations in equipment set-up can be observed in the table below:

Treatments	Tractor	Planter
A	Wheeled	Wheeled
B	Wheeled	Tracked
C	Tracked	Wheeled
D	Tracked	Tracked

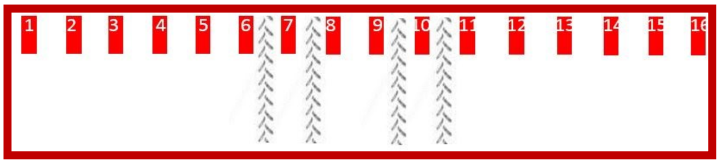
Planting pinch-row corn with a 16/31 row 1245 Case IH Planter on a Case IH Magnum 380 CVT.

OBSERVATIONS

During the growing season, no yield limiting factors were observed. Ample rains provided good crop health and vigor throughout the year.

Pinch Rows

Pinch row compaction is a common problem on every planter/tractor combination and especially bulk fill planters. Pinch rows are defined as any row that would be influenced due to compaction of the soil that falls within the tractor and/or implements footprint. To test this, there were 4 possible combinations including; wheeled tractor, tracked tractor, wheeled planter, tracked planter.



As seen above, Rows 6, 7, 8, 9, 10, 11 are all affected by this compaction either by the tractor, planter or both.

Growing Season

Precision Planting POGO Sticks (see right) along with the POGO App were used for stand count and growth staging scouting trips. While some effects of soil compaction were observed, there were no obvious treatment effects.

All yield data was recorded with the Precision Planting YieldSense yield monitor.

Tools of the Trade

Case IH Magnum 380 CVT

The Case IH 380 CVT tractor uses a continuously variable transmission to provide smooth field and road operations. The Ohio State Precision Ag Team employs multiple Magnum Tractors in their fleet.

Harvesting

The same harvest procedure was followed in this pinch row study as previous pinch row studies.

SUMMARY

- All yields were statistically the same, with the exception of the Tracked Tractor, Wheeled planter treatment.

KEY PARTNERS

The OSU Precision Ag team would like to thank the Beck's Hybrids for their assistance in growing season applications, and harvest logistics. Precision Planting supplied the POGO sticks for our team to collect the performance data throughout the growing season. CNH Industrial University loan program supplied the planting, tillage and harvesting equipment through Evolution Ag and Wellington Implement. We also would like to thank Camso for supplying tracks for the planter. Additionally, we want to thank Unverferth Manufacturing for supplying equipment to help with this project.

PROJECT CONTACT

For inquiries about this project, contact Andrew Klopfenstein—Senior Research Associate Engineer, Department of Food, Agricultural and Biological Engineering (klopfenstein.34@osu.edu).

Treatments	Yield (bu/ac)
Wheeled Tractor, Wheeled Planter	222 a
Wheeled Tractor, Tracked Planter	222 a
Tracked Tractor, Wheeled Planter	218 b
Tracked Tractor, Tracked Planter	224 a
Treatment Means with the same letter are not significantly different according to Fisher's Protected Least Significant Differences (LSD) test at alpha = 0.1.	LSD: 2.90 CV: 1.16%

Nitrogen Decision Trial

N - P - K

OBJECTIVE

Develop a nitrogen decision strategy based on in-season information about the crop condition and nitrogen availability.

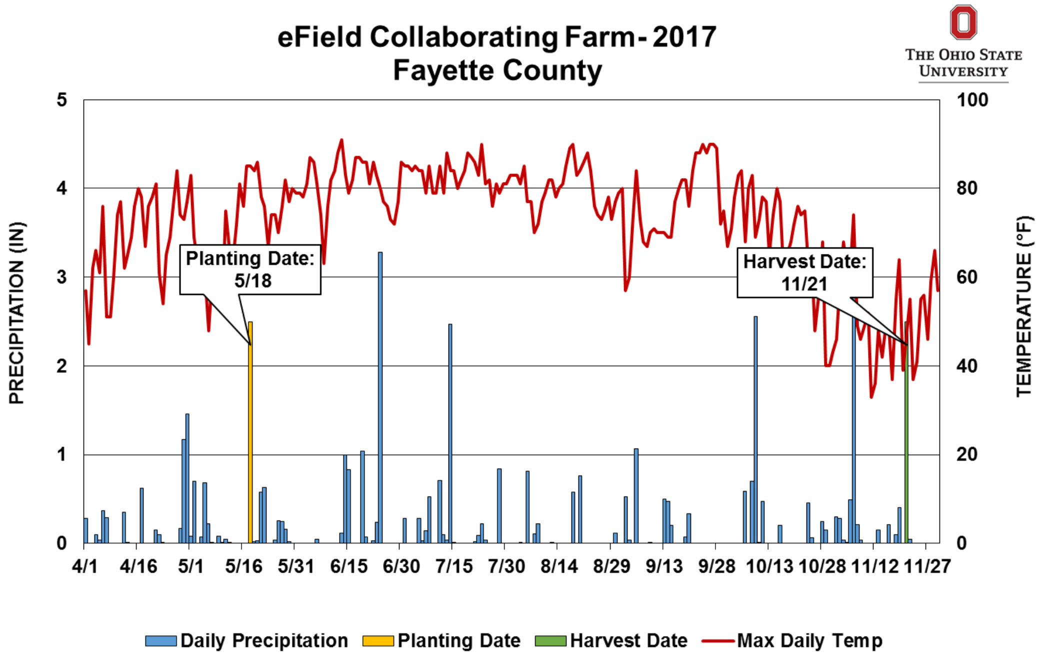
eFields Collaborating Farm

OSU Extension

Fayette County

STUDY INFORMATION

Planting Date	5/18/17
Harvest Date	11/21/17
Variety	SCS10HR43
Population	34,000 sds/ac
Acres	11.0
Treatments	6
Reps	4
Treatment Width	30 ft.
Tillage	Conventional
Previous Crop	Soybeans
Row Width	30 in.
Soil Type	Brookston silty clay loam (76%) Crosby silt loam (24%)



Weather Summary

Total	APR	MAY	JUN	JUL	AUG	Total
Precip (in)	5.12	3.90	6.66	5.80	2.62	24.10
Cumulative GDDs	235.0	589.0	1203.0	1927.0	2539.0	2539.0

STUDY DESIGN

Properly managing nitrogen fertilizer is challenging due to its responsiveness to field and environmental variability. Currently, nitrogen rate recommendations are heavily based on yield goals. This results in an increased risk of excess nitrogen being lost and adversely impacting the environment. Side-dress and late-season nitrogen source was 28%.

Treatments (lbs N applied at planting)	V5		V10	
	Soil N (lbs/ac)	Tissue N (%)	Soil N (lbs/ac)	Tissue N (%)
0	50	4.6	25	3.1
180	186	4.8	96	3.9
100	80	4.8	56	3.5

*4.0-5.0% N tissue sufficiency level at V5, 3.5-4.5% N tissue sufficiency level at V10

OBSERVATIONS

Nitrogen applications were planned for at planting, V5 sidedress, and post-V10 late-season. Soil and tissue samples were used to estimate plant uptake and soil nitrogen availability for decision making. Crop health was assessed to adjust yield expectations.

Nutrient Availability

Soil tests showed the levels of available N in the soils decreased by approximately 50% between V5 and V10. Tissue test results indicated sufficient N uptake in all treatments except the zero N rate at V10.

Aerial view of the nitrogen plots during the August field day.

Crop Health

Emergence was good. Crop condition remained good for most of the season, with low incidence of disease. A period of dry weather occurred following tasseling.

Tools of the Trade

NutraBoss

Nitrogen Application Equipment

The NutraBoss Applicator can be used to execute late season nitrogen applications.

SUMMARY

- The V5 sidedress application resulted in a slight increase in yield.
- Dry weather following the late-season application may have limited the crops ability to utilize the applied UAN 28%.

KEY PARTNERS

The OSU Digital Ag Team would like to thank Seed Consultants for donating the seed for this project. Also, thanks to Beck's Hybrids for providing UAV services for project support.

PROJECT CONTACT

For inquiries about this project, contact Elizabeth Hawkins, Assistant Professor, Field Specialist, Department of Extension (hawkins.301@osu.edu).

Treatments	Total N Applied (lbs/ac)	NUE (lbs N/bu/ac)	Moisture (%)	Yield (bu/ac)
At Plant Control	180	0.85	16.3	212 ab
V5 Control	180	0.84	16.1	214 b
V5 Decision	180	0.84	16.2	214 b
V10 Control	180	0.87	16.4	206 ab
V10 Decision	130	0.65	16.3	199 a
Zero N	0	-	16.4	93 c
Treatment Means with the same letter are not significantly different according to Fisher's Protected Least Significant Differences (LSD) test at alpha = 0.1.				LSD: 14.8

Nitrogen Decision Trial

N - P- K

OBJECTIVE

Develop a nitrogen decision strategy based on in-season information about the crop condition and nitrogen availability.

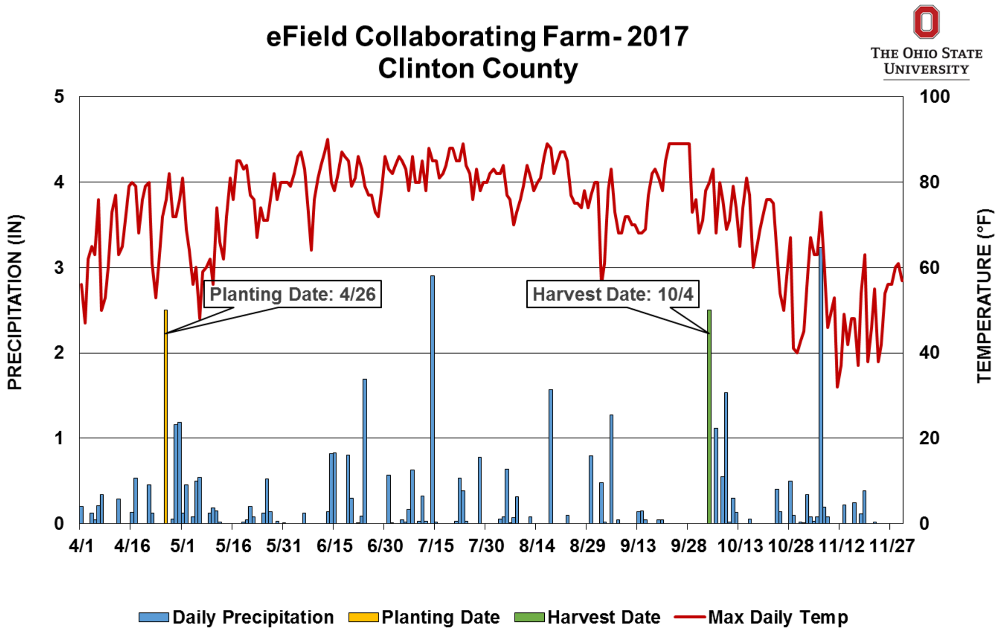
eFields Collaborating Farm

OSU Extension

Clinton County

STUDY INFORMATION

Planting Date	4/26/17
Harvest Date	10/4/17
Variety	P1197AM
Population	35,000 Sds/ac
Acres	20.4
Treatments	7
Reps	4
Treatment Width	40 ft.
Tillage	Vertical
Previous Crop	Soybeans
Row Width	30 in.
Soil Type	Xenia silty loam (55%) Treaty silty loam (25%)



Weather Summary

Total	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**Total**
Precip (in)	4.83	3.32	4.80	6.49	3.70	23.14
Cumulative GDDs	248.0	614.0	1225.0	1941.0	2536.0	2536.0

STUDY DESIGN

Properly managing nitrogen fertilizer is challenging due to its responsiveness to field and environmental variability. Currently, nitrogen rate recommendations are heavily based on yield goals. This results in an increased risk of excess nitrogen being lost and adversely impacting the environment.

Treatments (lbs N applied at planting)	**V5**		**V10**	
	Soil N (lbs/ac)	**Tissue N (%)**	**Soil N (lbs/ac)**	**Tissue N (%)**
0	99	4.6	14	3.0
210	395	5.1	115	3.8
45	68	5.2	116	3.8

*4.0-5.0% N tissue sufficiency level at V5, 3.5-4.5% N tissue sufficiency level at V10

OBSERVATIONS

Nitrogen applications were planned for at planting, V5 sidedress, and post-V10 late-season. Soil and tissue samples were used to estimate plant uptake and soil nitrogen availability for decision making. Crop health was assessed to adjust yield expectations.

Nutrient Availability

Soil tests showed the levels of available N in the soils were increasing through the season, indicating good mineralization. Tissue test results indicated sufficient N uptake in all treatments except the zero N rate at V10.

UAV aerial view of nitrogen strips late-season.

Crop Health

Despite heavy rains and cold temperatures after planting, the crop had strong emergence and good early vigor. Crop conditions remained good through the remaining part of the growing season.

Tools of the Trade

DJI Phantom 4

Quad-Copter Drone

The DJI Phantom 4 was used to assist in scouting throughout the year. The Nitrogen trials were flown during the growing season to reveal treatment differences.

SUMMARY

- An increased N rate showed a slight yield increase at V5.
- Delaying N rate decisions allows for more information about the season to be collected and used to make the decision.
- Success of late–season N application may depend on sufficient base rates and soil moisture at application.

PROJECT CONTACT

For inquiries about this project, contact Elizabeth Hawkins, Assistant Professor, Field Specialist, Department of Extension (hawkins.301@osu.edu).

Treatments	Total N Applied (lbs/ac)	NUE (lbs N/bu/ac)	Moisture (%)	Yield (bu/ac)
At Plant	210	0.83	20.3	254 a
V5 OSU Decision	210	0.81	20.6	260 a
V5 Grower Decision A	225	0.87	21.0	260 a
V5 Grower Decision B	240	0.87	21.6	275 b
V10 OSU Decision	215	0.85	21.1	254 a
V10 Grower Decision	215	0.83	21.1	258 a
Zero N	0	-	18.5	128 c
Treatment Means with the same letter are not significantly different according to Fisher’s Protected Least Significant Differences (LSD) test at alpha = 0.1.				LSD: 11.9

Nitrogen Source

N - P - K

OBJECTIVE

Determine the effects of nitrogen source on corn yield and profitability.

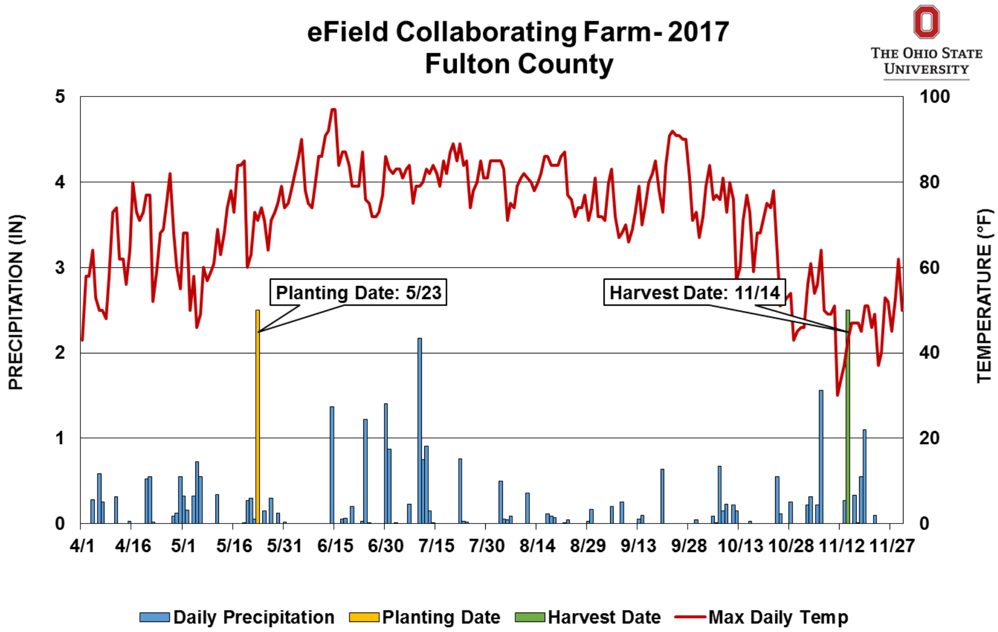
eFields Collaborating Farm

OSU Extension

Fulton County

STUDY INFORMATION

Planting Date	5/23/2017
Harvest Date	11/14/2017
Variety	Pioneer 0843 AM
Population	33,000 sds/ac
Acres	19.1
Treatments	4
Reps	4
Treatment Width	30 ft.
Tillage	No Till
Herbicide	Cinch ATZ, Instagate
Pesticide	Tombstone
Previous Crop	Soybeans
Row Spacing	30 in.
Soil Type	Colwood Loam Bixler loamy fine sand



Weather Summary

Total	APR	MAY	JUN	JUL	AUG	Total
Precip (in)	3.30	3.63	4.34	5.91	1.56	18.74
Cumulative GDDs	145.0	420.0	1020.0	1714.0	2292.0	2292.0

STUDY DESIGN

High speed, low disturbance nutrient application systems have been recently adopted which allow for a variety of nitrogen products to be injected below the soil surface at sidedress. This study evaluated four nitrogen sidedress source systems after 80 lbs of nitrogen was applied at planting.

Treatments	Application	Equipment System
28% UAN	43 gal/ac	Spray King
82% Anhydrous	159 lb/ac	Countryside Implements
46% Urea	283 lb/ac	John Deere 2510H
45% ESN	289 lb/ac	John Deere 2510H

Sidedress application of dry products

OBSERVATIONS

Throughout the year, plant growth was monitored for any potential treatment differences. No yield limiting factors were observed.

All sidedress applications of nitrogen were made on June 19th. Approximately 0.3" of rain was observed in 24 hours immediately after sidedress.

Cornstalk nitrate tests were evaluated at 10 days post black layer to evaluate nitrate-nitrogen levels at maturity. Yields were determined by weigh wagon and commercial moisture checks.

SUMMARY

- No significant difference found among anhydrous, urea and ESN sources (systems). The 28% check showed a significantly lower yield than the other 3 treatments.
- Nitrogen use efficiency (NUE) was maximized in the anhydrous and urea systems.
- Additional replications and year-over-year data will add to the validity of these results.

Tools of the Trade

High Speed, Low Disturbance (HSLD)

Nutrient Application Coulter

Several agricultural equipment manufacturers now offer a high speed, low disturbance system for placing nutrients below the surface. John Deere's 2510H is one such toolbar that allows for dry, liquid or gas nutrient placement in an efficient and environmentally friendly way.

KEY PARTNERS

OSU Extension-Fulton County would like to thank on farm collaborators Les & Jerry Seiler for planting and harvesting the plot. Additionally this study could not have been possible without Kenn-Feld Group John Deere, Countryside Implements, Crop Production Services, Neu-Brook Pioneer Seeds, the Dr. Culman fertility lab and OSUE interns Ross Andre and Kaitlin Ruetz.

PROJECT CONTACT

For inquiries about this project, contact Eric Richer, Extension Educator, Agriculture and Natural Resources, Ohio State University Extension– Fulton County (richer.5@osu.edu).

Treatments	Total N (lbs/ac)	CSNT (ppm NO3-N)	Moisture (%)	Yield (bu/ac)	Yield Diff. (bu/ac)	NUE (lbsN/bu)
28% UAN	210	162	22.4	215 b	-	0.98
82% AA	210	645	23.1	231 a	+16	0.91
46% Urea	210	78	22.8	229 a	+14	0.92
45% ESN	210	424	23.3	225 a	+10	0.93

Treatment Means with the same letter are not significantly different according to Fisher's Protected Least Significant Differences (LSD) test at alpha = 0.1.

Starter Fertilizer—Zn, S

N - P- K

OBJECTIVE

To measure corn yield effect from added Starter Fertilizer, Sulfur, and Zinc.

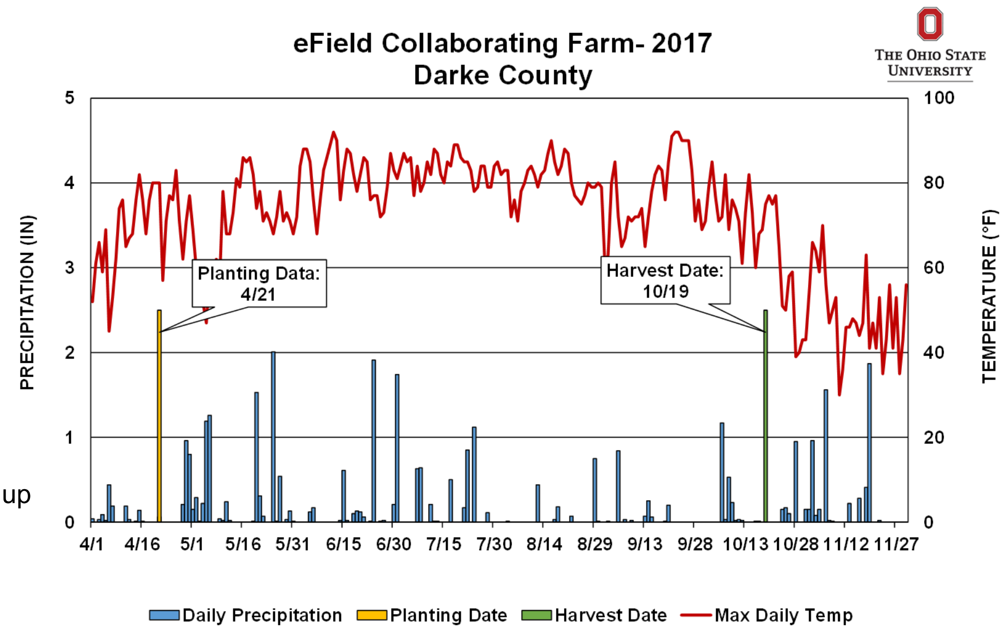
eFields Collaborating Farm

OSU Extension

Darke County

STUDY INFORMATION

Planting Date	4/21/2017
Harvest Date	10/19/2017
Variety	Dekalb 6188
Population	33,000 sds/ac.
Acres	5.2
Treatments	5
Reps	3
Treatment Width	30 ft.
Tillage	No-Till
Herbicide	Lexar and Roundup
Pesticide	N/A
Previous Crop	Soybeans
Row Width	30 in.
Soil Type	Crosby silt loam (95%) Brookston loam (5%)



Weather Summary

Total	APR	MAY	JUN	JUL	AUG	Total
Precip (in)	3.45	8.08	3.49	6.91	1.46	23.39
Cumulative GDDs	265.0	595.0	1237.0	1978.0	2590.0	2590.0

STUDY DESIGN

This experiment utilizes a randomized complete block design with a minimum of three replications. Plot widths are 30 feet. Plot lengths are a minimum of 500 feet. Weigh wagon and/or combine yield monitor data was utilized for measurement of corn yield. The combine was calibrated in season. Treatments included combinations of Starter Fertilizer with various amounts of zinc and sulfur.

Treatments	Source	Applied N (lbs/ac)	Applied P2O5 (lbs/ac)	Applied Sulfur (gal/acre)	Applied Zinc (quart/acre)
A	28% Only	43	-	-	-
B	28% , 10-34-0	43	23	-	-
C	28%, 10-34-0, Sulfur	43	23	2	-
D	28% , 10-34-0, Sulfur, Zinc	43	23	2	1
E	No Treatment	-	-	-	-

OBSERVATIONS

Throughout the year, plant growth was monitored for any potential treatment differences. There were color differences observed in the treatments.

Emergence

Uneven emergence took place in this field but seemed consistent across the treatments.

Treatments were applied in a 2x2 system at planting

Tools of the Trade

Ohio State Plots App

On-farm Research App

The Ohio State Plots App enables growers to layout in-field research trials, calculate statistics, and share results.

SUMMARY

- No statistical difference between yields.
- There appears to be no response to the additional fertilizer within this field that is in the maintenance range for nutrients.

PROJECT CONTACT

Sam Custer, Extension Educator, Agriculture and Natural Resources, Ohio State University Extension – Darke County (custer.2@osu.edu).

Treatments	Moisture (%)	Yield (bu/ac)
28% Only	19.5	201 a
28% and 10-34-0	19.4	194 a
28%, 10-34-0 and Sulfur	18.8	183 a
28%, 10-34-0, Sulfur, and Zinc	19.0	202 a
No Treatment	20.0	203 a

Treatment Means with the same letter are not significantly different according to Fisher's Protected Least Significant Differences (LSD) test at alpha = 0.1.

LSD: 18.2

CV: 6.09%

Swine Manure Dragline Side-dress

N - P- K

OBJECTIVE

Develop research-based results for the effective use of a dragline manure system to economically and environmentally side-dress corn.

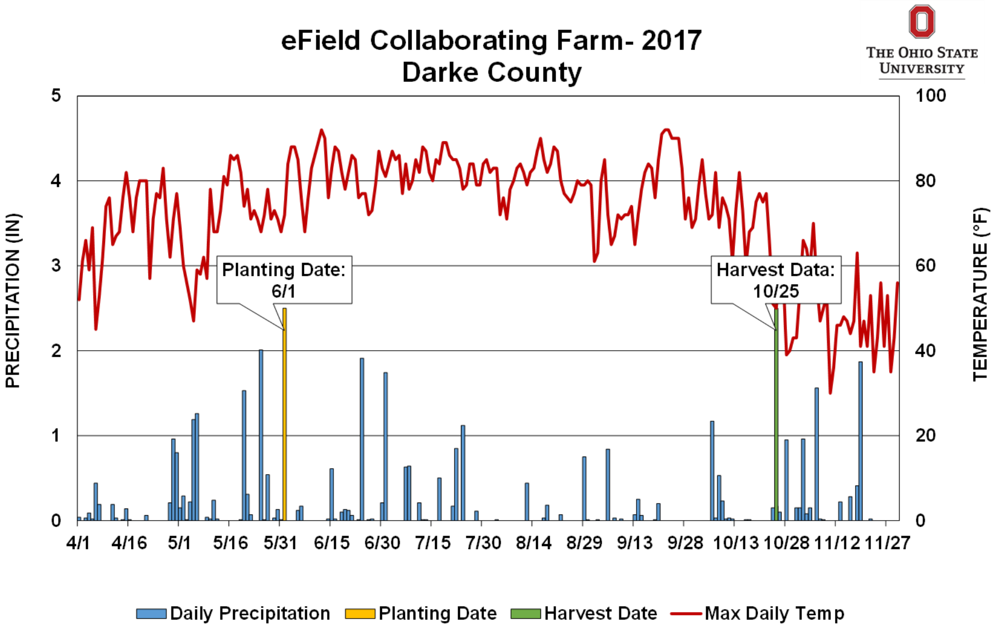
eFields Collaborating Farm

OSU Extension

Darke County

STUDY INFORMATION

Planting Date	6/1/2017
Harvest Date	10/25/2017
Variety	Pioneer 0157AMX
Population	33,000 sds/ac.
Acres	75.0
Treatments	2
Reps	3
Treatment Width	30 ft.
Tillage	Conventional
Herbicide	N/A
Pesticide	N/A
Previous Crop	Soybeans
Row Width	30 in.
Soil Type	Blount silt loam (82%) Pewamo clay loam (18%)



Weather Summary

Total	APR	MAY	JUN	JUL	AUG	Total
Precip (in)	3.45	8.08	3.49	6.91	1.46	23.39
Cumulative GDDs	265.0	595.0	1237.0	1978.0	2590.0	2590.0

STUDY DESIGN

For livestock farmers to better reach the goals of the 4R nutrient management approach they must be able to use their liquid manure by injecting it in the ground in a growing crop at nutrient level rates.

This experiment utilized a randomized complete block design with a minimum of three replications. Plot width depended on collaborating farmer's equipment for both planting, and harvesting. The combine was calibrated in season to ensure accurate yield monitor data. Harvest passes from the center of plots were extracted for treatment comparisons. Stand counts were taken at V4.

Treatments	Nitrogen App Rate (lbs N/ac)
28%	20.8
Side-dress Manure	21.1

OBSERVATIONS

Throughout the year, plant growth was monitored for any potential treatment differences. No yield limiting factors were observed.

No weed pressure was present, but there was significant leaf disease pressure in this replanted field. The hybrid available had low tolerance for gray leaf spot and Northern Corn Leaf blight. Fungicide was applied at pollination.

Liquid manure being applied at side-dress.

This system was used to apply manure at sidedress. The applicator injects manure as the dragline crosses the field with the machine.

Tools of the Trade

Bombauer Manure Toolbar

Drag hose manure applicator

The Bombauer Manure Toolbar used in this study offers growers the opportunity to apply manure as a sidedress application.

SUMMARY

- There was significant yield advantage of 20 bu/ac with side-dress manure application.
- Four years of research show a 13 bu/ac advantage with side-dress manure application.

PROJECT CONTACT

Sam Custer, Extension Educator, Agriculture and Natural Resources, Ohio State University Extension – Darke County (custer.2@osu.edu).

Treatments	Moisture (%)	Yield (bu/ac)
28%	20.8	146 a
Side-dress Manure	21.1	166 b

Treatment Means with the same letter are not significantly different according to Fisher's Protected Least Significant Differences (LSD) test at alpha = 0.1.

LSD: 5.42

CV: 1.45%

Dairy Manure Dragline Side-dress

N - P- K

eFields Collaborating Farm

OSU Extension

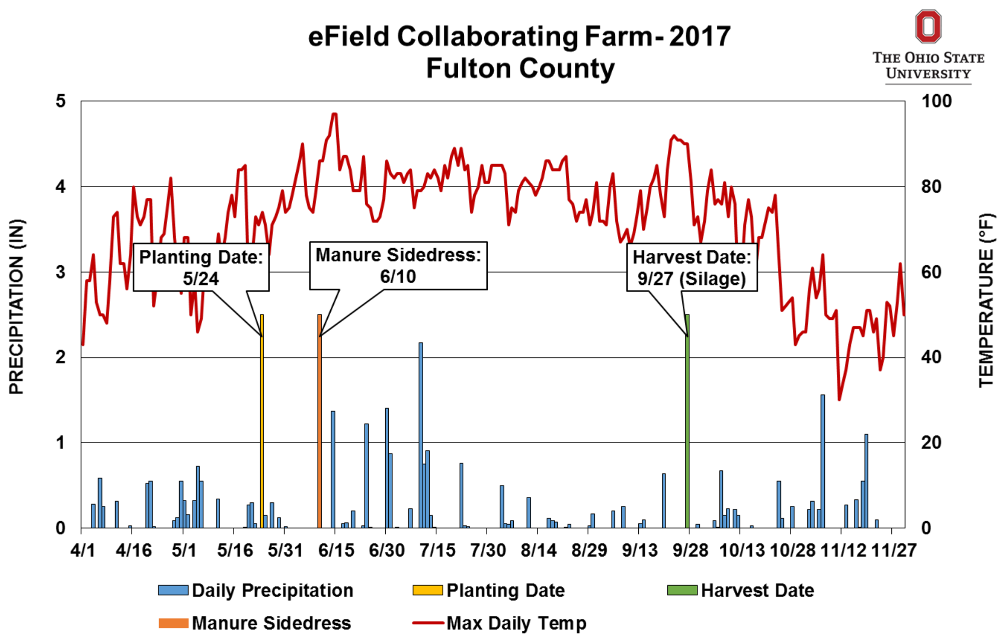
Fulton County

OBJECTIVE

Compare the yields of corn side-dressed with liquid dairy manure versus commercial nitrogen.

STUDY INFORMATION

Planting Date	5/24/2017
Harvest Date	9/27/2017 (Silage)
Variety	Mycogen TMF2A637
Population	34,000 sds/ac
Acres	7.0
Treatments	2
Reps	4
Treatment Width	30 ft.
Tillage	No-Till
Herbicide	BiCep II Magnum, glyphosate
Pesticide	N/A
Previous Crop	Corn
Row Spacing	30 in.
Soil Type	Colonie fine sand Gilford



Weather Summary

Total	APR	MAY	JUN	JUL	AUG	Total
Precip (in)	3.30	3.63	4.34	5.91	1.56	18.74
Cumulative GDDs	145.0	420.0	1020.0	1714.0	2292.0	2292.0

STUDY DESIGN

Historically, the manure application window closes once corn has been planted. OSU Extension has conducted tanker liquid manure trials in standing corn since the 2000's but recently began doing demonstrations and research trials with commercial liquid manure application in standing corn at side-dress. In 2017, a 40-acre dragline trial was conducted in Fulton County using approximately 10,000 gallons of dairy lagoon manure. A manure analysis showed nutrient of the manure to be:

15 lbs Ammonia-N

4 lbs $P_2 0_5$

9 lbs $K_2 0$ per 1,000 gallons

Use of the manure at sidedress allowed for the capture of ammonia-N that may otherwise be lost.

Liquid dairy manure being injected with a commercial dragline in standing corn.

OBSERVATIONS

Preliminary research at OARDC-Northwest has shown that a dragline can be used up to V4 corn with no significant stand loss. Sidedress manure was applied on June 12th and four 12–row check strip were left where commercial nitrogen was applied in anhydrous form on the same day.

Pictures of corn at treatment on June 12th (left) and one week after treatment on June 19th (right).

Observations were made on a weekly basis after manure application to evaluate plant recovery. Additionally, corn stalk nitrate tests (CSNT) data was collected at 10 days post-black layer to evaluate if sufficient nitrate nitrogen was available to the plant. Corn was harvested for silage in late September. Silage yields were weighed and shrunk to 100% dry matter for comparison.

Corn has shown to tolerate two passes with a draghose up to the four-leaf stage (V4).

Tools of the Trade

Bazooka Farmstar Manure Injection Toolbar

Manure injection toolbars, like this one from Bazooka Farmstar, allow for liquid manure injection at corn sidedress, capturing valuable ammonia N for the corn plant. Commercial manure application—efficient & effective.

SUMMARY

- Nitrate levels for both treatments were in Optimal ranges (250-2,000 ppm, Purdue).
- Nutrient consistency in dairy manure varies, thus having a possible impact on yield results.
- A significant difference (less) in dry matter silage yield was observed when only dairy manure was used as the nitrogen source.

KEY PARTNERS

The author expresses appreciation to on-farm collaborators Emmons Dairy for the planting and harvesting of this plot. Special thanks to those providing support to purchase the manure injection toolbar including Bazooka Farmstar, Conservation Action Project, Cooper Farms, Hord Livestock, and the Columbus Foundation. Thanks to Frey Brothers for commercial application, Tim Stutzman for harvesting the trial, OSUE Manure Nutrient Specialist Glen Arnold for coordination and OSUE interns Ross Andre and Kaitlin Ruetz for assistance with data collection.

PROJECT CONTACT

Eric Richer, Extension Educator, Agriculture and Natural Resources, Ohio State University Extension– Fulton County (richer.5@osu.edu).

Treatments	Application Rate	N Rate (lbs/ac)	Wet Yield (T/ac)	Dry Yield (T/ac)	Moisture (%)	Stand Count (ppa)	CSNT (ppm)
82% Anhydrous	159 lbs/ac	130	21.3	8.9 a	58.1	31,250	1991
Dairy Manure	10,000 gal/ac	150	20.1	8.0 b	60.0	32,125	618

Treatment Means with the same letter are not significantly different according to Fisher's Protected Least Significant Differences (LSD) test at alpha = 0.1.

Remote Sensing - Health Monitoring

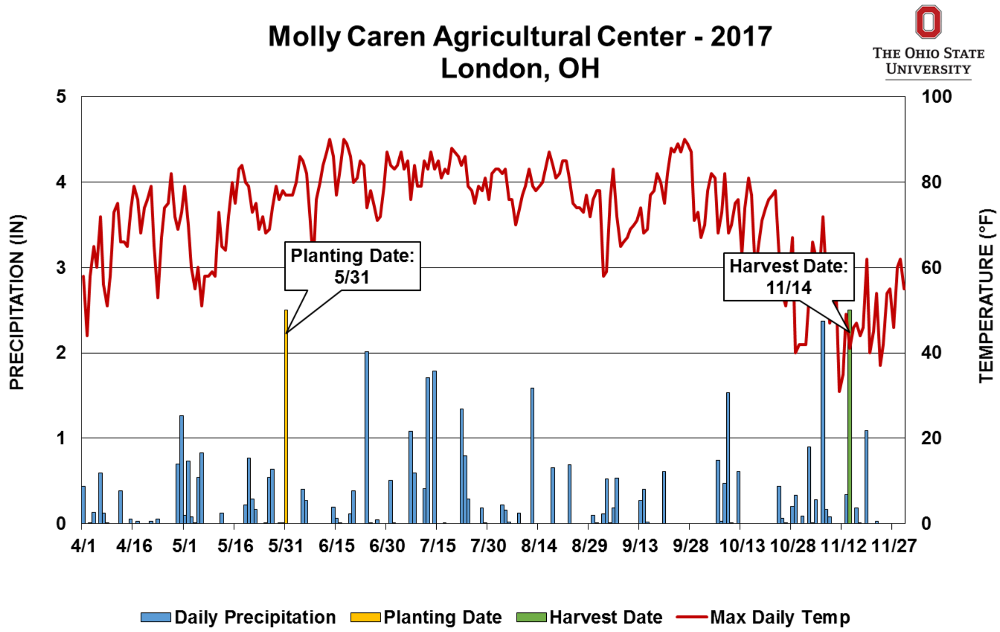
OBJECTIVE

Quantify canopy cover of corn plants as a measure of corn health to evaluate the effectiveness of tracks versus wheels on planting tractors and central fill planters using drone collected images.

Molly Caren
Agricultural Center
Madison County

STUDY INFORMATION

Planting Date	5/31/17
Harvest Date	11/14/17
Variety	P1197AM
Population	34,886 sds/ac
Acres	56.5
Treatments	4
Reps	6
Treatment Width	40 ft.
Tillage	Conventional
Previous Crop	Soybean
Row Width	30 in.
Soil Type	Crosby-Lewisburg silt loam (58%) Kokomo silty clay loam (42%)



Weather Summary

Total	APR	MAY	JUN	JUL	AUG	Total
Precip (in)	3.80	5.07	3.48	8.72	2.65	23.72
Cumulative GDDs	216.0	551.0	1124.0	1823.0	2404.0	2404.0

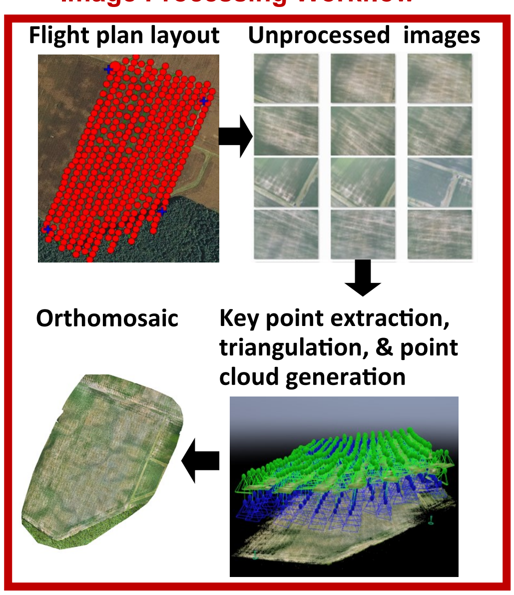
STUDY DESIGN

Use of large and heavy equipment during planting can result in soil compaction that can adversely impact corn production. This study uses drone collected high-resolution images to evaluate the impact of tracks versus wheels on planting tractors and central fill planters on canopy cover of corn plants. Drone collected images were processed to create geo-rectified orthomosaic map, and analyzed to estimate the canopy cover of corn plants in various treatments.

Study Treatments	Soil Productivity*
Wheeled Tractor—Wheeled Planter (W-W)	Good
Wheeled Tractor—Tracked Planter (W-T)	Medium
Tracked Tractor—Wheeled Planter (T-W)	High
Tracked Tractor—Tracked Planter (T-T)	

*Historic corn yield data was used to classify soil into three productivity zones.

Image Processing Workflow



OBSERVATIONS

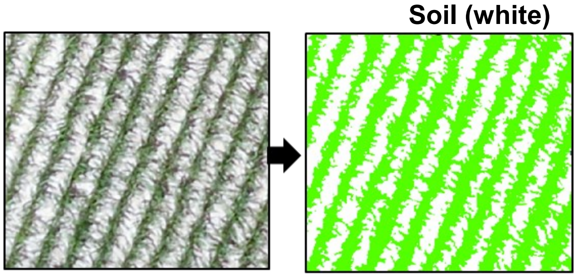
Orthomosaic visual images at V6 corn growth stage were classified into corn and non-corn areas to estimate corn canopy cover for all corn rows. Percent area covered by corn canopy was evaluated for any potential treatment differences across soils of good, medium, and poor productivity levels in corn planted rows. Canopy cover varied significantly across three soil types, with good soils having higher corn canopy cover. In general, canopy cover was lower in compacted (i.e., pinch rows) compared to un-compacted rows.

Tools of the Trade

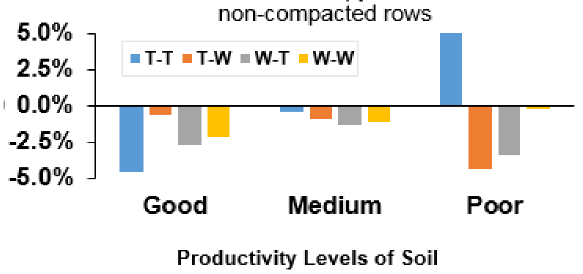
eBee Drone

Drones provide farmers the opportunity to visualize entire fields from an aerial perspective. Drone collected images help detect area of concerns, and execute farming operations more effectively and efficiently, including crop scouting, and crop and soil health monitoring.

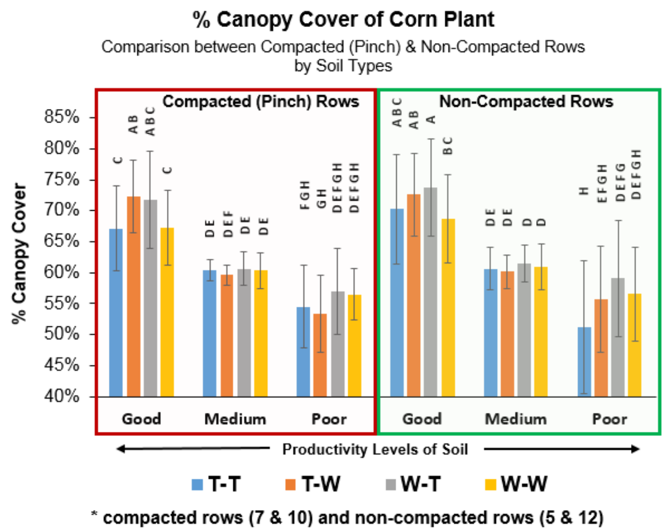
Workflow for Estimating Canopy Cover



$$\text{\% Canopy Cover} = \frac{Green\ Area}{Total\ Area\ (Green + White)}$$



Compaction had adverse impact on good soils compared to poor soils.



Tracked tractor & tracked planter performed better than wheeled tractor & wheeled planter

PROJECT CONTACT

Sami Khanal, Research Scientist,
Department of Food, Agricultural and Biological Engineering
(Khanal.3@osu.edu).

SUMMARY

- Impact of treatments on corn canopy cover varied by soil types.
- Compared to T-T, pinch rows of W-W always had lower corn canopy cover.
- T-T resulted in lower canopy cover in pinch rows with good soils, but higher in poor soils.
- Based on remote sensing images at V6 growth stage, except for a few treatments (i.e., T-W and W-W in good soils), no clear pattern was observed between other treatments. Further studies need to be conducted.

KEY PARTNERS

The OSU Precision Ag team would like to thank Nate Douridas from the Molly Caren Agricultural Center for logistical support, student workers for data collection, and John Deere, Soucy, and Camso for equipment support. Thanks to OARDC-Seed Grants program for providing funding support.

Remote Sensing - Corn Yield Mapping

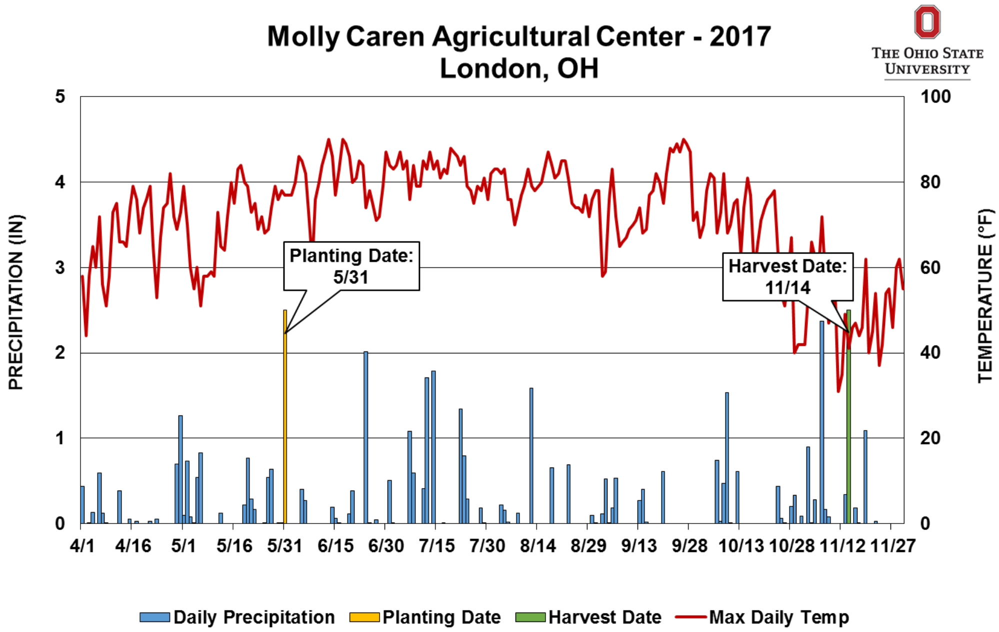
OBJECTIVE

Understand the potentials of remote sensing imagery for corn yield mapping.

Molly Caren
Agricultural Center
Madison County

STUDY INFORMATION

Planting Date	5/31/17
Harvest Date	11/14/17
Variety	P1197AM
Population	34,886 sds/ac
Acres	56.5
Treatments	4
Reps	6
Treatment Width	40 ft.
Tillage	Conventional
Previous Crop	Soybean
Row Width	30 in.
Soil Type	Crosby-Lewisburg silt loam (58%) Kokomo silty clay loam (42%)



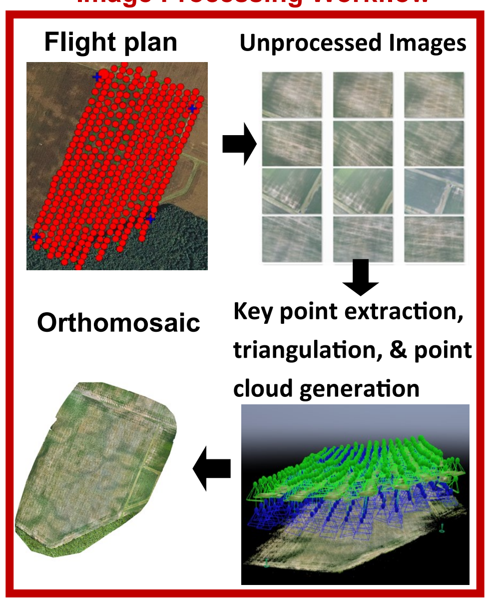
Weather Summary

Total	APR	MAY	JUN	JUL	AUG	Total
Precip (in)	3.80	5.07	3.48	8.72	2.65	23.72
Cumulative GDDs	216.0	551.0	1124.0	1823.0	2404.0	2404.0

STUDY DESIGN

This study uses drone collected high-resolution (i.e., 12 cm) multispectral images, yield data collected at harvest, and the topographic information of a corn field to develop in-season corn yield prediction models. High-resolution multispectral images of a corn field were collected at V2, V6, and R1 growth stages. The field was under four treatments, evaluating the effectiveness of tracks versus wheels on planting tractors and central fill planters on corn production.

Image Processing Workflow



Study Treatments	Soil Productivity*
Wheeled Tractor—Wheeled Planter (W-W)	Good
Wheeled Tractor—Tracked Planter (W-T)	Medium
Tracked Tractor—Wheeled Planter (T-W)	High
Tracked Tractor—Tracked Planter (T-T)	

*Historic corn yield data was used to classify soil into three productivity zones.

OBSERVATIONS

Predicted corn yield values were compared with yield data from yield monitor. Despite some variability between the range of yield values based on yield monitor and prediction models, the geographical distribution of predicted corn yield values was found to be similar to yield estimates from yield monitor.

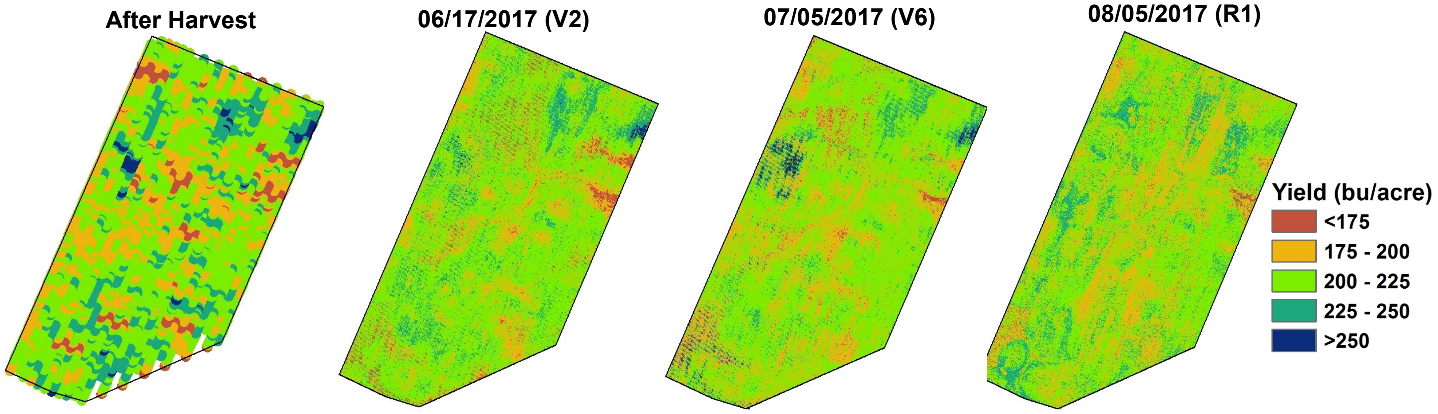
Yield prediction models at V2, V6, and R1 corn growth stages explained 53%, 66%, and 67% variability of the observed yield estimates, respectively.

Models were found to capture the spatial variability for most of the observed low and high spots in the field.

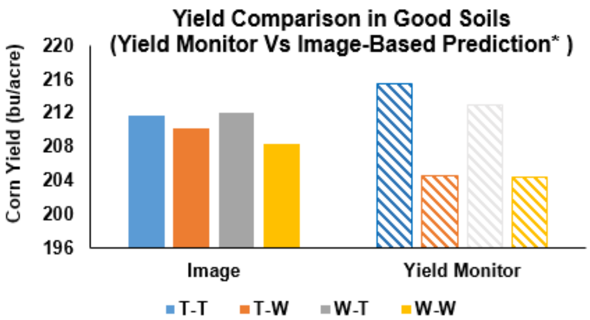
Tools of the Trade

Parrot Sequoia Multispectral Camera

The Sequoia multispectral sensor captures both visible and invisible images, providing calibrated data to optimally monitor the health and vigor of your crops. Sequoia captures calibrated wavelength, Green, Red, Red-Edge and Near Infrared to highlight the health of plants.



Remote sensing imagery collected at the later growth stage of corn provided higher accuracy in yield prediction.



Yields, both predicted and from the yield monitor showed similar impacts of treatments on corn yield in good soils.

SUMMARY

- Remote sensing imagery explained >53% yield variability of the observed data.
- Remote sensing imagery can be useful in detecting potential crop health issues early in the growing season.
- The yield map based on remote sensing imagery has a higher spatial resolution than the yield monitor yield map. Remote sensing imagery may serve as an attractive means to predict yield.

KEY PARTNERS

The OSU Precision Ag team would like to thank Nate Douridas from the Farm Science Review for logistical support, 3D Aerial for image acquisition, student workers for data collection, and John Deere, Soucy, and Camso for equipment support. Thanks to OARDC-Seed Grants program for providing funding support.

PROJECT CONTACT

Sami Khanal, Research Scientist, Department of Food, Agricultural and Biological Engineering (Khanal.3@osu.edu).

Seeding Rate Trials - Summary

OBJECTIVE

Understand the yield impact of varying corn seeding rates within Ohio considering in-field variability and cultural practices implemented. Information from this trial will be used to improve management recommendations for growers throughout Ohio understand how variable-rate seeding may impact field-by-field profit.

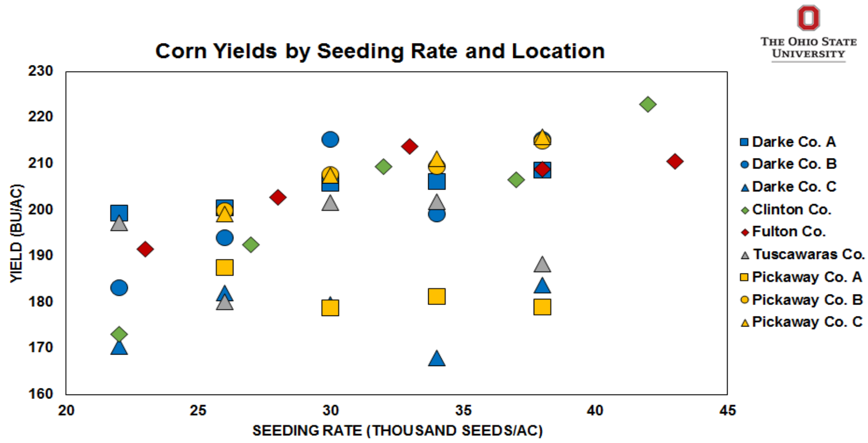
STUDY DESIGN

The primary recommendations for seeding rates in Ohio are determined by target final stands and “average” soil productivity. Variable-rate seeding prescriptions have the potential to better match seeding rate to productivity zones in an effort to optimize profits. Field studies were implemented in a strip-trial format and replicated at least three times within the fields. Results for individual sites were analyzed along with an aggregated pool of data for each location.

Planter equipped with variable-rate seeding ties.

Tools of the Trade

Sound information and data on corn hybrid selection and associated seeding rate for 1) planter or seeder, and 2) recommended final population.



SUMMARY

- Across all sites, the average corn emergence was 92% with individual sites ranging between 84% to 98%.
- Variation in corn yield was caused by differences in location and differences in seeding rates in 2017.
- There was a significant response to corn seeding rates at 6 out of 9 sites in 2017.

Spatial analyses will be used to uncover the causes of yield variation between sites and determine possible responses to seeding rate and emergence based on in-field variability at each site.

EXAMPLE FIELD LAYOUT

To maximize learning, a minimum of five different seeding rates should be compared. More rates can be added, if adequate space is available. The seeding rates compared in the trial need to be different enough to have the potential to affect yield, a minimum difference of 4,000 seeds/acre between each treatment is recommended. It may be necessary to adjust these seeding rates slightly based on your equipment capabilities.

Proper experimental design is important to ensure the validity of the yield results at the end of the season. Plot replication and randomization make it possible for statistical analysis to account for the natural field variation that occurs. For this study, a minimum of three replications should be used and four replications are recommended. Plots should be randomized within each replication to eliminate bias due to plot order.

Planter Pass	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Replication	1					2					3					4				
Plot ID	101	102	103	104	105	201	202	203	204	205	301	302	303	304	305	401	402	403	404	405
Description	34k	30k	38k	22k	26k	38k	26k	30k	22k	34k	22k	38k	26k	30k	34k	38k	30k	34k	22k	26k

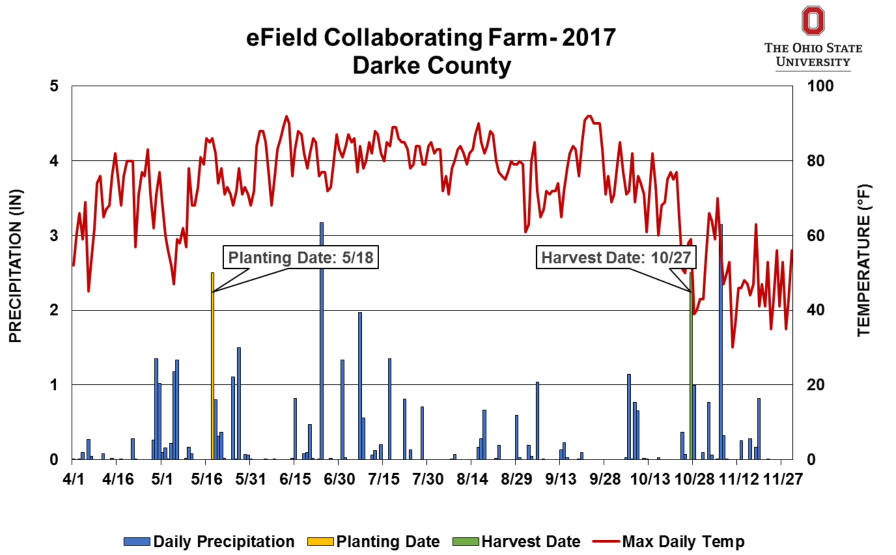
eFields Collaborating Farm

OSU Extension

Darke County – A

STUDY INFORMATION

Planting Date	5/18/2017
Harvest Date	10/27/17
Variety	P0825
Population	Treatments
Acres	17.0
Treatments	6
Reps	3
Treatment Width	40 ft.
Tillage	Conventional
Herbicide	Compreno, Aatrex, Roundup
Pesticide	None
Previous Crop	Soybeans
Row Spacing	30 in.
Soil Type	Crosby silt loam (25%) Celina silt loam (75%)



Weather Summary

Total	APR	MAY	JUN	JUL	AUG	Total
Precip (in)	3.45	8.08	3.49	6.91	1.46	23.39
Cumulative GDDs	265.0	595.0	1237.0	1978.0	2590.0	2590.0

PROJECT CONTACT

For inquiries about this project, contact Sam Custer, Extension Educator, Agriculture and Natural Resources, Ohio State University Extension - Darke County (custer.2@osu.edu).

Treatments (sds/ac)	Avg. Emergence (plants/ac)	Moisture (%)	Yield (bu/ac)
22,000	20,250	19.9	199 a
26,000	23,666	19.8	201 a
30,000	24,166	20.2	206 b
34,000	28,750	20.2	206 b
38,000	35,083	20.1	209 b
Grower Variable Rate	26,916	20.3	207 b

Treatment Means with the same letter are not significantly different according to Fisher's Protected Least Significant Differences (LSD) test at alpha = 0.1.

LSD: 5.24

CV: 1.73%

Seeding Rate Trials

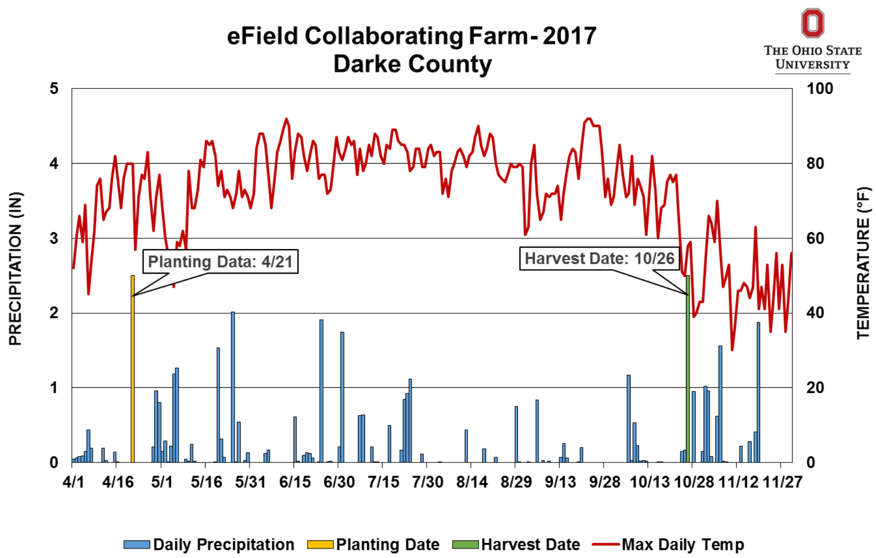
eFields Collaborating Farm

OSU Extension

Darke County – B

STUDY INFORMATION

Planting Date	4/21/2017
Harvest Date	10/26/2017
Variety	DKC6188
Population	Treatments
Acres	5.2
Treatments	5
Reps	3
Treatment Width	30 ft.
Tillage	No-Till
Herbicide	Compreno, Aatrex, Roundup
Pesticide	None
Previous Crop	Soybeans
Row Spacing	30 in.
Soil Type	Crosby silt loam (85%) Brookston silty clay loam (15%)



Weather Summary

Total	APR	MAY	JUN	JUL	AUG	Total
Precip (in)	3.45	8.08	3.49	6.91	1.46	23.39
Cumulative GDDs	265.0	595.0	1237.0	1978.0	2590.0	2590.0

PROJECT CONTACT

For inquiries about this project, contact Sam Custer, Extension Educator, Agriculture and Natural Resources, Ohio State University Extension - Darke County (custer.2@osu.edu).

Treatments (sds/ac)	Avg. Emergence (plants/ac)	Moisture (%)	Yield (bu/ac)
22,000	N/A	17.3	183 a
26,000	N/A	17.0	194 a
30,000	N/A	16.9	215 b
34,000	N/A	16.4	199 ab
38,000	N/A	16.5	215 b
Treatment Means with the same letter are not significantly different according to Fisher's Protected Least Significant Differences (LSD) test at alpha = 0.1.			LSD: 20.31 CV: 6.64%

CORN

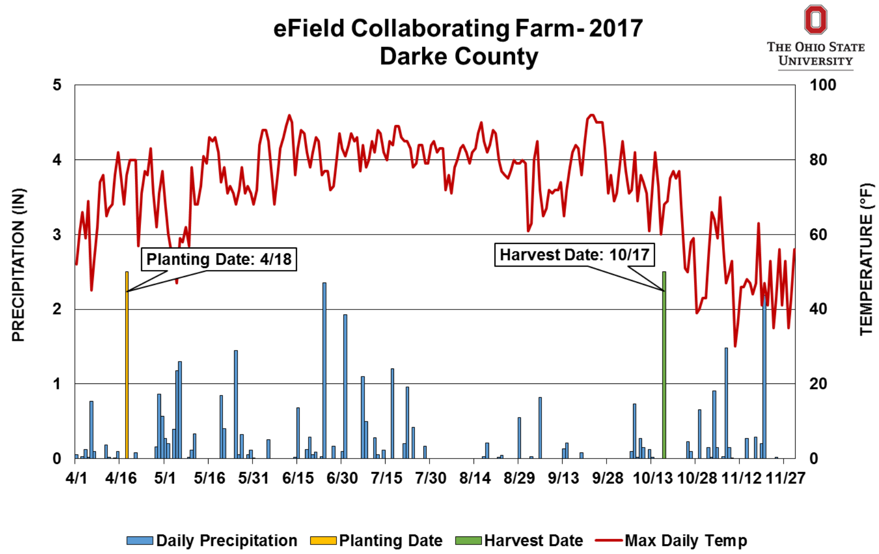
eFields Collaborating Farm

OSU Extension

Darke County – C

STUDY INFORMATION

Planting Date	4/18/2017
Harvest Date	10/17/2017
Variety	Channel 21359
Population	Treatments
Acres	9.2
Treatments	5
Reps	4
Treatment Width	40 ft.
Tillage	No-Till
Herbicide	Corvus, atrazine
Pesticide	None
Previous Crop	Soybeans
Row Spacing	30 in.
Soil Type	Crosby silt loam (32%) Brookston silty clay loam (68%)



Weather Summary

Total	APR	MAY	JUN	JUL	AUG	Total
Precip (in)	3.45	8.08	3.49	6.91	1.46	23.39
Cumulative GDDs	265.0	595.0	1237.0	1978.0	2590.0	2590.0

PROJECT CONTACT

For inquiries about this project, contact Sam Custer, Extension Educator, Agriculture and Natural Resources, Ohio State University Extension - Darke County (custer.2@osu.edu).

Treatments (sds/ac)	Avg. Emergence (plants/ac)	Moisture (%)	Yield (bu/ac)
22,000	16,812	18.2	170 a
26,000	21,312	18.0	182 a
30,000	25,750	17.8	180 a
34,000	30,437	17.5	168 a
38,000	33,250	17.6	184 a

Treatment Means with the same letter are not significantly different according to Fisher's Protected Least Significant Differences (LSD) test at alpha = 0.1.

LSD: * not significant

CV: 9.13%

Seeding Rate Trials

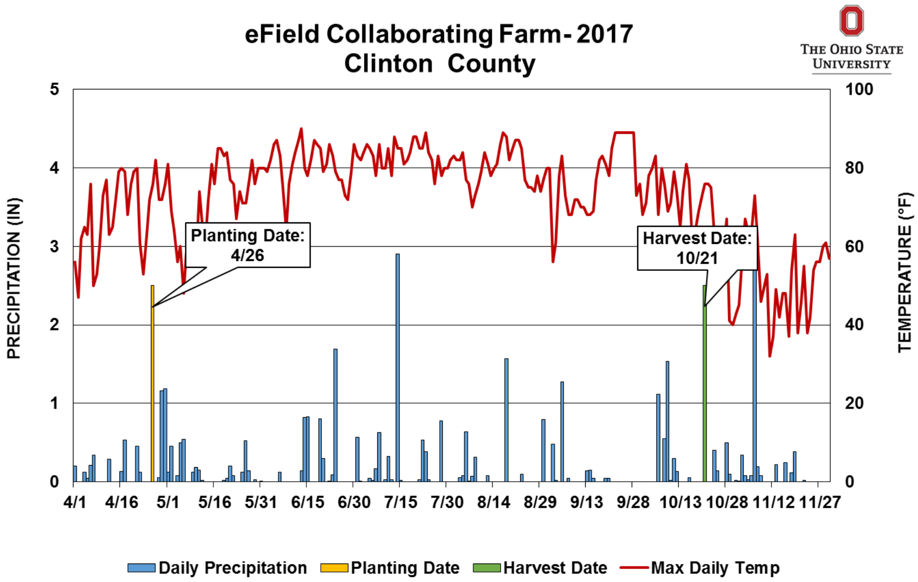
STUDY INFORMATION

Planting Date	4/26/2017
Harvest Date	10/21/2017
Variety	SCS 10HR43
Population	Treatments
Acres	9.6
Treatments	5
Reps	4
Treatment Width	20 ft.
Tillage	Conventional
Herbicide	N/A
Pesticide	None
Previous Crop	Soybeans
Row Spacing	30 in.
Soil Type	Xenia silt loam (46%) Treaty silty clay loam (68%)

eFields Collaborating Farm

OSU Extension

Clinton County



Weather Summary

Total	APR	MAY	JUN	JUL	AUG	Total
Precip (in)	4.83	3.32	4.80	6.49	3.70	23.14
Cumulative GDDs	248.0	614.0	1225.0	1941.0	2536.0	2536.0

PROJECT CONTACT

For inquiries about this project, contact Elizabeth Hawkins, Assistant Professor, Field Specialist, Department of Extension (hawkins.301@osu.edu).

Treatments (sds/ac)	Avg. Emergence (plants/ac)	Moisture (%)	Yield (bu/ac)
22,000	20,125	N/A	173 a
27,000	25,125	N/A	192 b
32,000	29,750	N/A	209 c
37,000	34,250	N/A	207 c
42,000	37,250	N/A	223 d

Treatment Means with the same letter are not significantly different according to Fisher's Protected Least Significant Differences (LSD) test at alpha = 0.1.

LSD: 10.88

CV: 4.30%

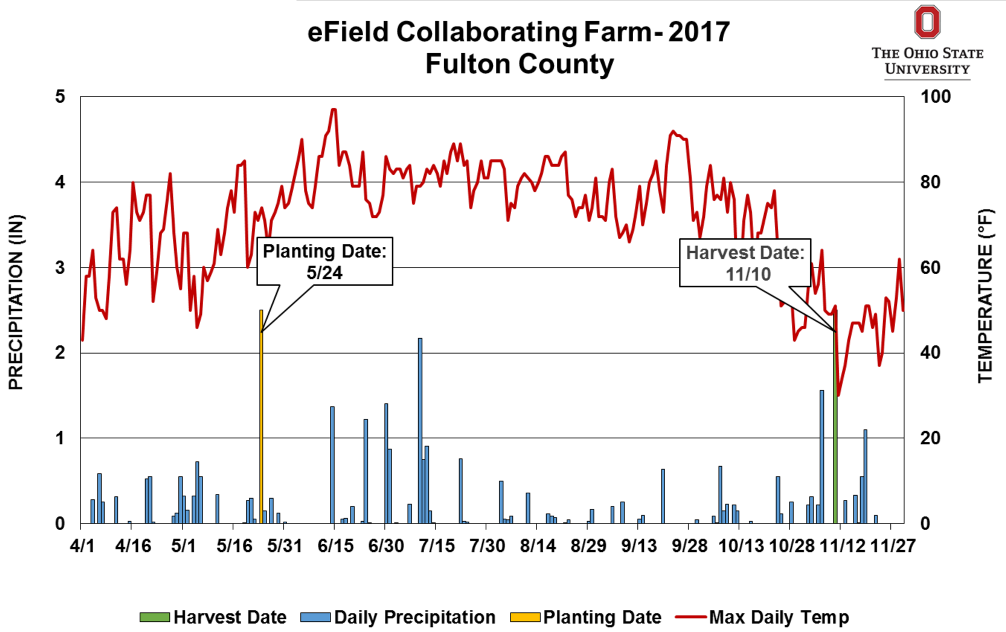
eFields Collaborating Farm

OSU Extension

Fulton County

STUDY INFORMATION

Planting Date	5/24/2017
Harvest Date	11/10/17
Variety	P0843
Population	Treatments
Acres	19.2
Treatments	5
Reps	4
Treatment Width	30 ft.
Tillage	No Till
Herbicide	Cinch ATZ, Instagate
Pesticide	Tombstone in furrow
Previous Crop	Soybeans
Row Spacing	30 in.
Soil Type	Colwood Loam Dixboro fine sandy loam



Weather Summary

Total	APR	MAY	JUN	JUL	AUG	Total
Precip (in)	3.30	3.63	4.34	5.91	1.56	18.74
Cumulative GDDs	145.0	420.0	1020.0	1714.0	2292.0	2292.0

PROJECT CONTACT

For inquiries about this project, contact Elizabeth Hawkins, Assistant Professor, Field Specialist, Department of Extension (hawkins.301@osu.edu).

Treatments (sds/ac)	Avg. Emergence (plants/ac)	Moisture (%)	Yield (bu/ac)
22,000	20,250	19.9	199 a
26,000	23,667	19.8	201 a
30,000	24,167	20.1	206 ab
34,000	28,750	20.2	206 ab
38,000	35,083	20.0	209 b
Grower Variable Rate	26,917	20.3	207 b

Treatment Means with the same letter are not significantly different according to Fisher's Protected Least Significant Differences (LSD) test at alpha = 0.1.

LSD: 5.24

CV: 1.73%

Seeding Rate Trials

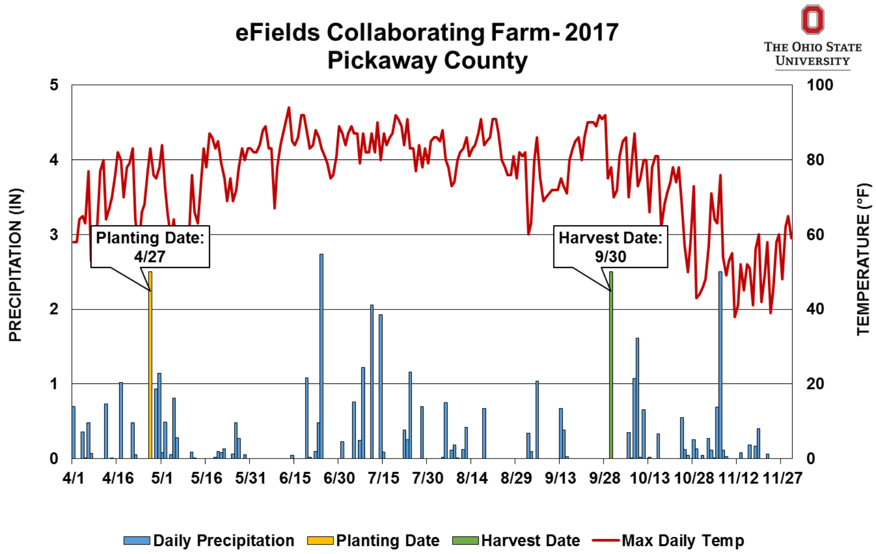
STUDY INFORMATION

Planting Date	04/27/2017
Harvest Date	09/30/2017
Variety	p5829A4
Population	Treatments
Acres	17.3
Treatments	4
Reps	5
Treatment Width	40 ft.
Tillage	Conventional
Herbicide	N/A
Pesticide	N/A
Previous Crop	Soybeans
Row Spacing	30 in.
Soil Type	Kokomo silty clay loam (42%) Crosby silt loam (37%) Miamian-Kendallville silt loam (11%)

eFields Collaborating Farm

OSU Extension

Pickaway County—A



Weather Summary

Total	APR	MAY	JUN	JUL	AUG	Total
Precip (in)	5.98	3.00	4.46	9.02	2.28	24.74
Cumulative GDDs	233.0	604.0	1266.0	2049.0	2738.0	2738.0

PROJECT CONTACT

For inquiries about this project, contact Elizabeth Hawkins, Assistant Professor, Field Specialist, Department of Extension (hawkins.301@osu.edu).

Treatments (sds/ac)	Avg. Emergence (plants/ac)	Moisture (%)	Yield (bu/ac)
26,000	N/A	18.2	199 a
30,000	N/A	18.1	208 b
34,000	N/A	17.9	211 bc
38,000	N/A	18.0	216 c
Treatment Means with the same letter are not significantly different according to Fisher's Protected Least Significant Differences (LSD) test at alpha = 0.1.			LSD: 6.2 CV: 2.64%

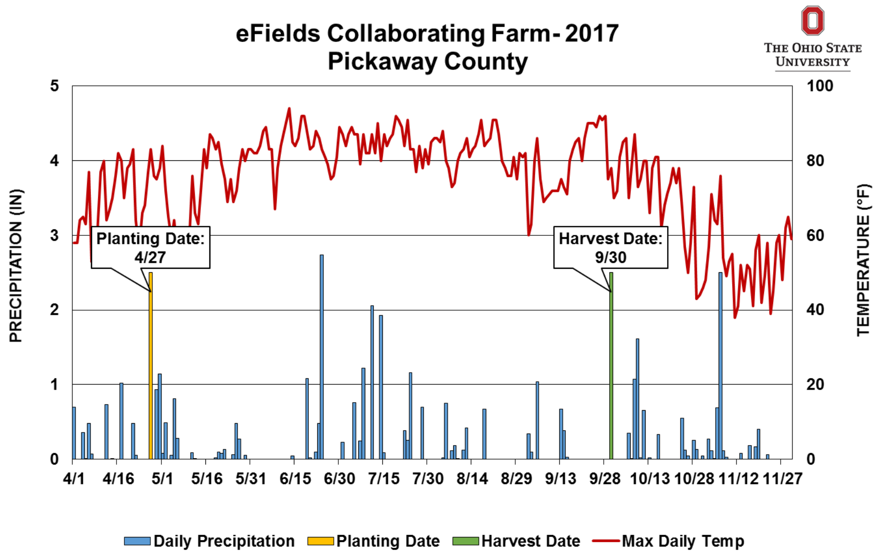
STUDY INFORMATION

Planting Date	04/27/2017
Harvest Date	09/30/2017
Variety	P0825AM
Population	Treatments
Acres	17.2
Treatments	4
Reps	5
Treatment Width	40 ft.
Tillage	Conventional
Herbicide	N/A
Pesticide	N/A
Previous Crop	Soybeans
Row Spacing	30 in.
Soil Type	Kokomo silty clay loam (42%) Crosby silt loam(37%) Miamian-Kendallville silt loam (11%)

eFields Collaborating Farm

OSU Extension

Pickaway County—B



Weather Summary

Total	APR	MAY	JUN	JUL	AUG	Total
Precip (in)	5.98	3.00	4.46	9.02	2.28	24.74
Cumulative GDDs	233.0	604.0	1266.0	2049.0	2738.0	2738.0

PROJECT CONTACT

For inquiries about this project, contact Elizabeth Hawkins, Assistant Professor, Field Specialist, Department of Extension (hawkins.301@osu.edu).

Treatments (sds/ac)	Avg. Emergence (plants/ac)	Moisture (%)	Yield (bu/ac)
26,000	N/A	18.3	200 a
30,000	N/A	18.4	208 ab
34,000	N/A	18.4	209 ab
38,000	N/A	18.6	215 b

Treatment Means with the same letter are not significantly different according to Fisher's Protected Least Significant Differences (LSD) test at alpha = 0.1.

LSD: 9.2

CV: 3.92%

Seeding Rate Trials

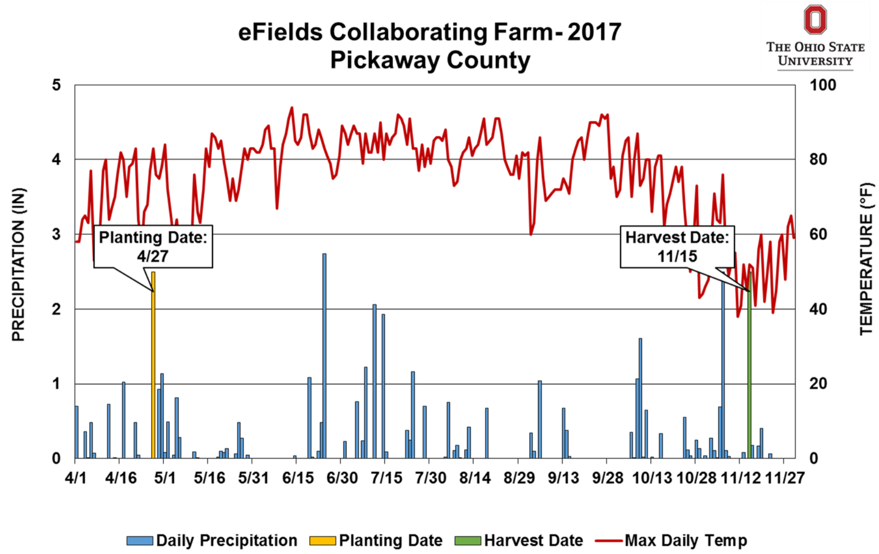
eFields Collaborating Farm

OSU Extension

Pickaway County—C

STUDY INFORMATION

Planting Date	04/27/2017
Harvest Date	11/15/2017
Variety	DKC61-55RIB, DKC62-20RIB
Population	Treatments
Acres	13.5
Treatments	4
Reps	5
Treatment Width	40 ft.
Tillage	Spring Vertical Till
Herbicide	N/A
Pesticide	N/A
Previous Crop	Soybeans
Row Spacing	30 in.
Soil Type	Kokomo silty clay loam (52%) Crosby silt loam (21%) Miamian-Lewisburg silt loam (27%)



Weather Summary

Total	APR	MAY	JUN	JUL	AUG	Total
Precip (in)	5.98	3.00	4.46	9.02	2.28	24.74
Cumulative GDDs	233.0	604.0	1266.0	2049.0	2738.0	2738.0

PROJECT CONTACT

For inquiries about this project, contact Elizabeth Hawkins, Assistant Professor, Field Specialist, Department of Extension (hawkins.301@osu.edu).

Treatments (sds/ac)	Avg. Emergence (plants/ac)	Moisture (%)	Yield (bu/ac)
26,000	N/A	18.5	188 a
30,000	N/A	18.6	179 a
34,000	N/A	18.7	181 a
38,000	N/A	18.7	179 a

Treatment Means with the same letter are not significantly different according to Fisher's Protected Least Significant Differences (LSD) test at alpha = 0.1.

LSD: 14.02

CV: 4.87%

CORN

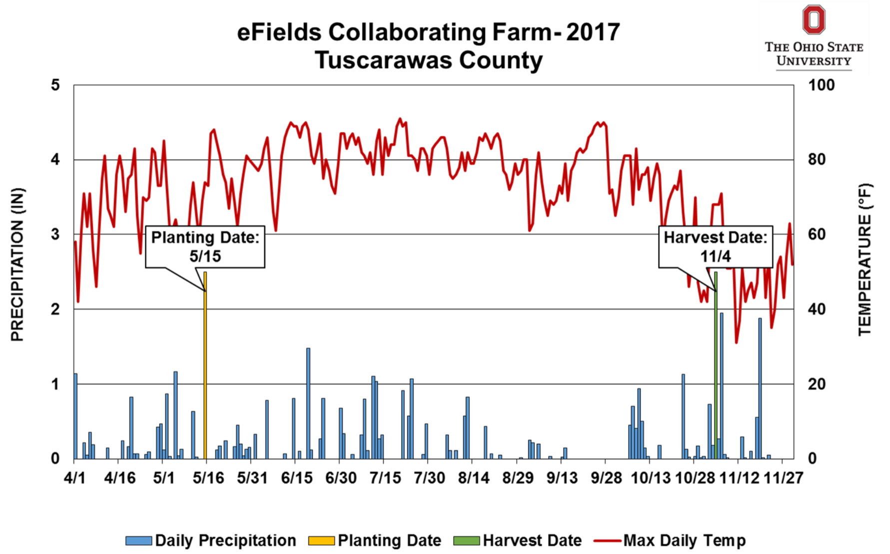
STUDY INFORMATION

Planting Date	05/15/2017
Harvest Date	11/04/2017
Variety	Channel 207-27
Population	Treatments
Acres	9.48
Treatments	5
Reps	3
Treatment Width	90 ft.
Tillage	Vertical Till
Herbicide	Lexar EZ
Pesticide	Lambda
Previous Crop	Soybeans
Row Spacing	30 in.
Soil Type	Sebring silt loam Fitchville silt loam Licking silt loam

eFields Collaborating Farm

OSU Extension

Tuscarawas County



Weather Summary

Total	APR	MAY	JUN	JUL	AUG	Total
Precip (in)	4.48	4.66	5.45	7.43	2.49	24.51
Cumulative GDDs	215.0	527.0	1099.0	1822.0	2442.0	2442.0

PROJECT CONTACT

For inquiries about this project, contact Elizabeth Hawkins, Assistant Professor, Field Specialist, Department of Extension (hawkins.301@osu.edu).

Treatments (sds/ac)	Avg. Emergence (plants/ac)	Moisture (%)	Yield (bu/ac)
22,000	21,667	21%	197 a
26,000	24,333	20.8%	180 a
30,000	27,333	21%	202 a
34,000	31,333	21.3%	202 a
38,000	37,000	20.7%	188 a
Treatment Means with the same letter are not significantly different according to Fisher's Protected Least Significant Differences (LSD) test at alpha = 0.1.			LSD: 23.19 CV: 7.88%

Ohio State Soybean Research

For 2017, **eFields** soybean research was focused on improving the production and profitability of soybeans in the greater Ohio area. Some exciting and innovating projects were executed this year, with over 20 unique studies being conducted across the state. 2017 soybean research presented in **eFields** covers both precision seeding and compaction management Digital Ag Team initiatives. Below are highlights of some of the 2017 **eFields** soybean research:

eFields Soybean Summary

- 1,018 acres of soybeans
- 24 soybean studies

For more soybean research from The Ohio State University's Department of Extension, explore the following resources:

2017 Ohio Soybean Performance Tests

The purpose of the Ohio Soybean Performance Trials is to evaluate soybean varieties for yield and other agronomic characteristics. This evaluation gives soybean producers comparative information for selecting the best varieties for their unique production systems. For more information: http://go.osu.edu/OhioSoybean

Agronomic Crops Team—Soybean Research

The Agronomic Crops Team performs interesting research studies on a yearly basis. Resources, fact sheets, and articles on soybean research can be found here on the Agronomic Crops Team website: http://go.osu.edu/CropsTeamSoybean

The Ohio State Precision Ag Program

The Ohio State Precision Ag Program conducts studies related to all aspects of the soybean production cycle. Research related to soybean planting, cropping inputs, and harvesting technology can be found on the Precision Ag website: http://go.osu.edu/PrecisionAg

Growth Stages:

For all soybean studies in this eFields report, we define soybean growth stages as the following:

VE - Emergence - Cotyledons appear above the soil surface and provide nutrients for 7 to 10 days.

VC - Cotyledons have fully expanded and unifoliate leaves have unfolded.

V1 - First Trifoliate: Second true node, first node at which a trifoliate leaf is produced. Nodules visible.

V2 - Two fully developed trifoliates unfolded. The plant is roughly 8 in. tall. Nodules are actively fixing nitrogen. Cotyledons have fallen off plant.

V3-V4 - A dramatic increase in the number of nodules visible on roots takes place by these stages.

V5-V_N - Lateral roots extend 15 in. away from main stem and grow to the center of 30 in. rows. Branches begin developing on the lowest nodes. Total number of nodes the plant may produce is set at V5.

R1 - Beginning Bloom - one flower is open at any node on the main stem.

R2 - Full Bloom - An open flower at one of the two uppermost nodes of the main stem with a fully developed leaf.

R3 - Beginning Pod - Pods are 3/16 in. long at one of the four uppermost nodes on the main stem.

R4 - Full Pod - Pod is 3/4 in. long at one of the four uppermost nodes on the main stem. This the most critical period for seed yield.

R5 - Beginning Seed - Seed in one of the four uppermost nodes with fully developed leaves is 1/8 in. long.

R6 - Full Seed - Pod containing a green seed filling the pod cavity is present at one of the top four nodes.

R7 - Beginning Maturity - One normal pod on the main stem has reached its mature pod color.

R8 - Full Maturity - Ninety-five percent of the pods on the plant have reached their mature color. Approximately 5 to 10 days of good drying weather is needed to bring crop to less than 15% moisture.

Adapted from Stewart Seeds Corn and Soybean Growth Stages Guide, 2013.

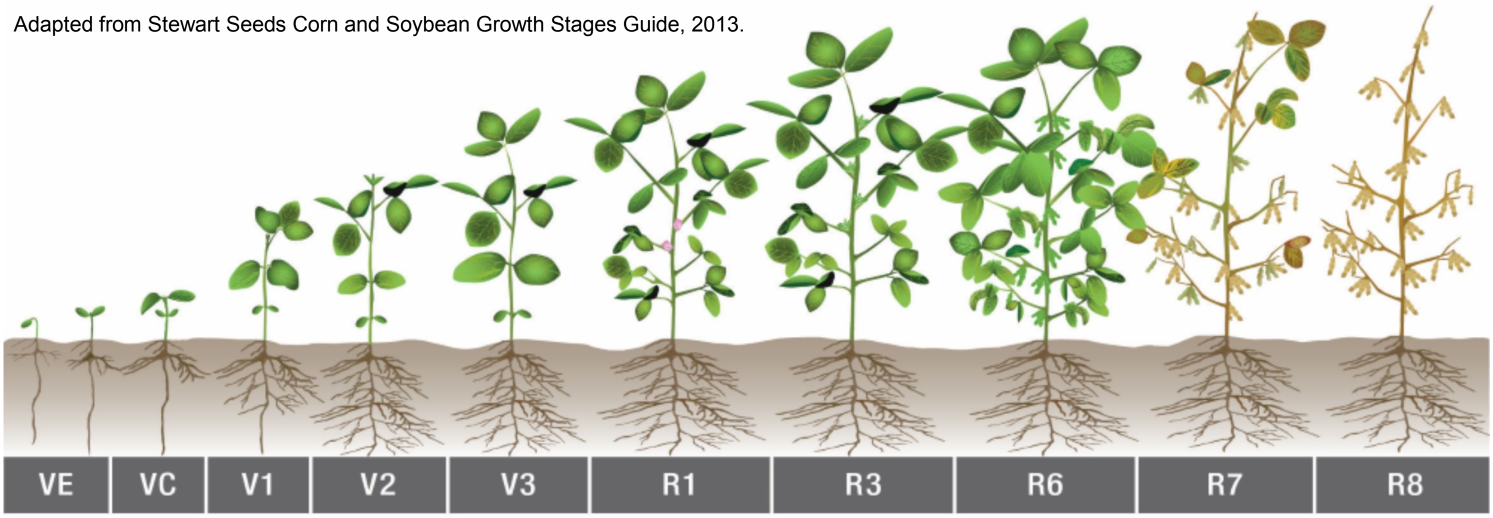


Image Source: University of Illinois Agronomy Guide, 1999.

Planter Downforce in Strip-Till

OBJECTIVE

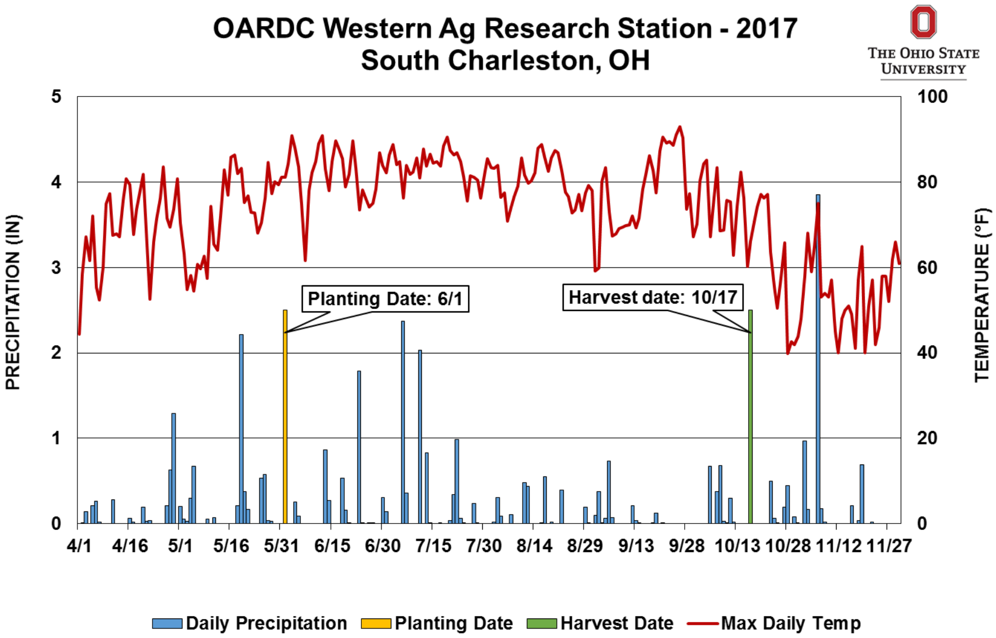
Understand planter downforce levels and the need to adjust when changing from no-till to strip-till management.

Western Agricultural Research Station

Clark County

STUDY INFORMATION

Planting Date	6/1/17
Harvest Date	10/17/17
Variety	P36T14R
Population	130,000 sds/ac
Acres	18.1
Treatments	6
Reps	4
Treatment Width	40 ft.
Tillage	Strip-Till
Herbicide	N/A
Pesticide	N/A
Previous Crop	Corn
Row Width	30 in.
Soil Type	Kokomo silty clay (48%) Strawn-Crosby complex (52%)



Weather Summary

Total	APR	MAY	JUN	JUL	AUG	Total
Precip (in)	3.39	5.52	4.30	7.44	2.62	23.27
Cumulative GDDs	235.0	571.0	1144.0	1900.0	2580.0	2580.0

STUDY DESIGN

Planter downforce systems have recently been adopted for modern planters. Substantial research has been done on recommended downforce (DF) levels for no-till managed fields, but little research for strip-till (ST) managed treatments. This study evaluated various downforce (DF) levels in strip-till managed treatments.

Treatments	Tillage	Applied Downforce (lbs)*	Emergence (%)
Control	No-Till	100	87.9
Optimal	Strip-Till	100	82.1
Heavy	Strip-Till	195	79.6
Light	Strip-Till	50	76.9

*Measured as additional load applied at gauge wheel

A Case IH 2150 16-row Planter with Precision Planting DeltaForce downforce control system.

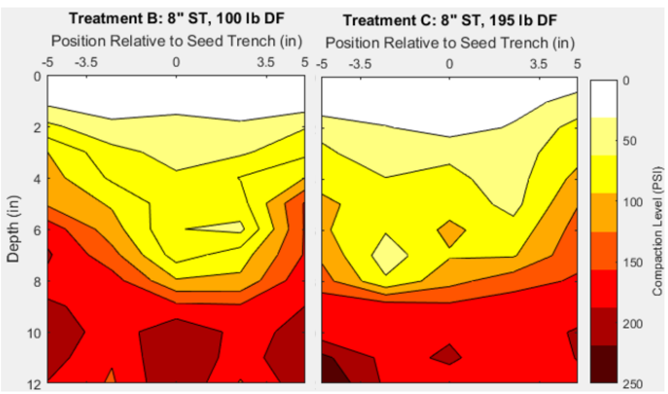
OBSERVATIONS

Throughout the year, plant growth was monitored for any potential treatment differences. No yield limiting factors were observed except for minor headland weed pressure.

Emergence

Expected emergence results were observed between strip-till treatments with the “optimal” DF level having greater emergence over to Heavy and No DF treatments.

Variance in emergence was observed for the 50 lb downforce treatment.



Soil compaction measurements taken after planting show minimal compaction from over applied DF.

Tools of the Trade

Precision Planting DeltaForce

Hydraulic row by row downforce control

DeltaForce helps the row unit place seeds at precisely the right depth by maintaining an accurate load on the row unit. Pairing DeltaForce with the 20/20 display allows the operator to observe and adjust row unit downforce levels in real-time.

Compaction

Penetrometer readings show strip-till was effective in reducing the level of compaction, and the highest level of applied DF (195 lb) did the best job of consolidating soil within the strip.

SUMMARY

- No significant yield benefits to utilizing different downforce control systems, however it did appear to affect emergence.
- Highest downforce level achievable did not over compact the soil.
- Optimal (100 lb DF) provided the best emergence of the strip-till treatment.

KEY PARTNERS

The OSU Precision Ag team would like to thank the WARS staff for their assistance in growing season applications, and harvest logistics. Thanks to Pioneer for donating the seed. Orthman’s donation of the strip-till bar was also appreciated, along with planting and harvesting equipment from Evolution Ag.

PROJECT CONTACT

For inquiries about this project, contact Trey Colley, Graduate Research Assistant, Department of Food, Agricultural and Biological Engineering (Colley.65@osu.edu).

Treatments	Downforce (lbs)	Moisture (%)	Yield (bu/ac)
Control	100	12.1	61 a
Optimal	100	13.7	59 a
Heavy	195	13.4	61 a
Light	50	13.0	61 a

Treatment Means with the same letter are not significantly different according to Fisher’s Protected Least Significant Differences (LSD) test at alpha = 0.1.

Pinch Row Soybeans

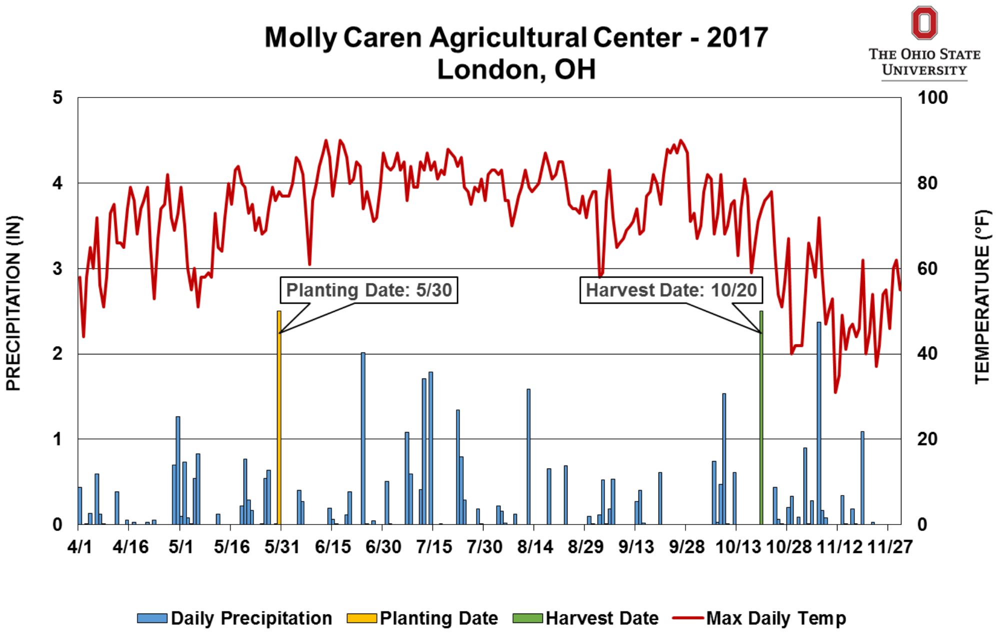
OBJECTIVE

Evaluate if utilizing tracks on either the tractor or planter would reduce soil compaction in cropping rows influenced by field traffic.

Molly Caren
Agricultural Center
Madison County

STUDY INFORMATION

Planting Date	5/30/17
Harvest Date	10/20/17
Variety	LGC3770R2
Population	136,000 sds/ac
Acres	23.8
Treatments	2
Reps	7
Treatment Width	40 ft.
Tillage	Conventional
Previous Crop	Corn
Row Width	30 in.
Soil Type	Crosby-Lewisburg silt loam (62%) Kokomo silty clay (38%)



Weather Summary

Total	APR	MAY	JUN	JUL	AUG	Total
Precip (in)	3.80	5.07	3.48	8.72	2.65	23.72
Cumulative GDDs	216.0	551.0	1124.0	1823.0	2404.0	2404.0

STUDY DESIGN

Tracked systems for planters have become popular options for attempting to reduce soil compaction in the rows adjacent to the paths of equipment travel. Multiple combinations of these tracked systems were evaluated and the tested variations in equipment set-up can be observed in the table below:

Treatments	Tractor	Planter
A	Tracked	Wheeled
B	Tracked	Tracked

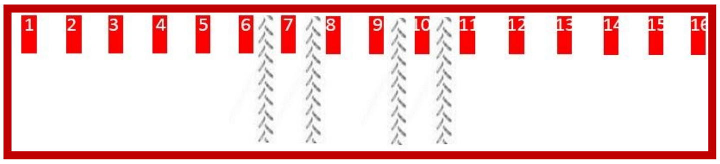
Planting operations for both treatments was conducted with a Tracked Tractor (top). Planter variations included: Tracks (left), and Wheels (right).

OBSERVATIONS

Previously, the majority of planter tracking research has been dedicated to corn production. The Ohio State Precision Ag Team decided to investigate the effects of planter track systems on soybeans.

Pinch Rows

Pinch row compaction is a common problem on every planter/tractor combination and especially bulk fill planters. Pinch rows are defined as any row that would be influenced due to compaction of the soil that falls within the tractor and/or implements footprint. To test this, there were 4 possible combinations including; wheeled tractor, tracked tractor, wheeled planter, tracked planter.



As seen above, Rows 6, 7, 8, 9, 10, 11 are all affected by this compaction either by the tractor, planter or both.

Growing Season

Throughout the growing season, the crop was monitored and no yield-limiting factors were observed. The field was scouted at multiple points throughout the growing season to investigate the effects of soil compaction on the "pinch rows" of the study. While some effects of soil compaction were observed, there were no obvious treatment effects.

Plant samples taken during scouting show height reduction in the wheeled planter Treatment (left), from the tracked planter treatment (right).

Tools of the Trade

Camso Track System

The Camso track systems for tractors offer the ability to increase the soil surface to track ratio, which in turn reduces soil compaction levels. In this study, the tracks were installed on a JD 8320 R tractor.

Harvesting

In order to harvest the desired area of interest, a 25 ft. header was used to harvest the center sections of each test strip.

SUMMARY

- No statistical differences were detected in the yields of either treatment.

KEY PARTNERS

Nate Douridas, Farm Manager at the Molly Caren Agricultural Center, as well as the rest of the Molly Caren staff for their contributions to this study. We also would like to thank Camso for providing tracks for the tractor. Additionally, thanks to SoucyTrack for supplying tracks for the planter.

PROJECT CONTACT

For inquiries about this project, contact Andrew Klopfenstein—Senior Research Associate Engineer, Department of Food, Agricultural and Biological Engineering (klopfenstein.34@osu.edu).

Treatments	Moisture (%)	Yield (bu/ac)
Tracked Tractor, Wheeled Planter	10.5	64 a
Tracked Tractor, Tracked Planter	10.3	64 a
Treatment Means with the same letter are not significantly different according to Fisher's Protected Least Significant Differences (LSD) test at alpha = 0.1.		LSD *not significant CV: 2.12%

Pinch Row Soybeans

OBJECTIVE

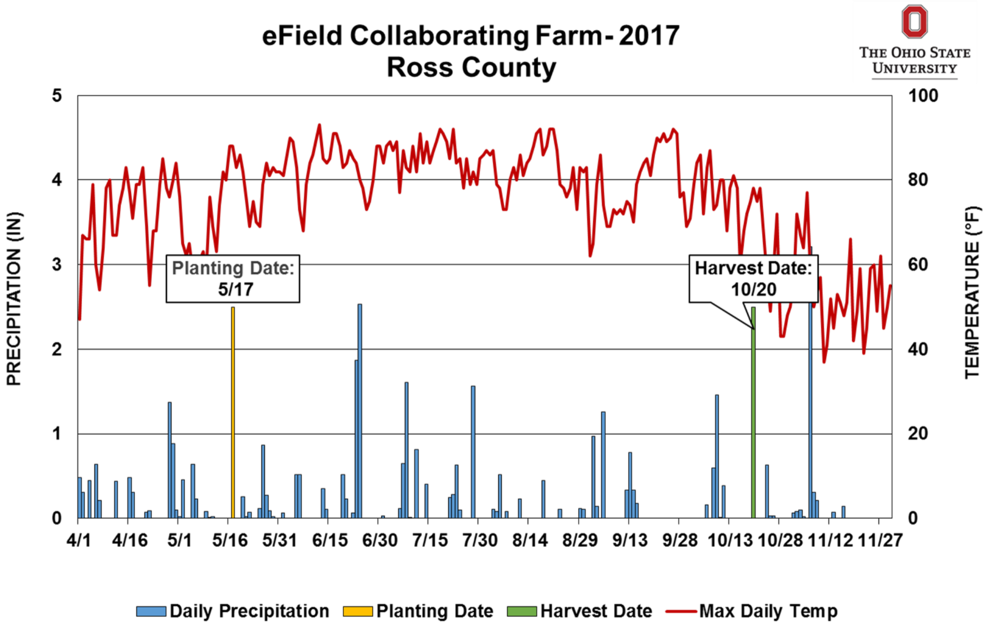
Evaluate if utilizing tracks on either the tractor or planter would reduce soil compaction in cropping rows influenced by field traffic.

Beck's Hybrids

Ross County

STUDY INFORMATION

Planting Date	5/17/17
Harvest Date	10/20/17
Variety	Beck's 345R4
Population	155,000 sds/ac
Acres	270.6
Treatments	4
Reps	5
Treatment Width	40 ft.
Tillage	Conventional
Previous Crop	Corn
Row Width	15 in.
Soil Type	Rossburg silt loam (63%) Ross



Weather Summary

Total	APR	MAY	JUN	JUL	AUG	Total
Precip (in)	5.83	3.18	6.77	6.45	1.81	24.04
Cumulative GDDs	325.0	767.0	1447.0	2241.0	2933.0	2933.0

STUDY DESIGN

Tracked systems for planters have become popular options for attempting to reduce soil compaction in the rows adjacent to the paths of equipment travel. Multiple combinations of these tracked systems were evaluated and the tested variations in equipment set-up can be observed in the table below:

Treatments	Tractor	Planter
A	Wheeled	Wheeled
B	Wheeled	Tracked
C	Tracked	Wheeled
D	Tracked	Tracked

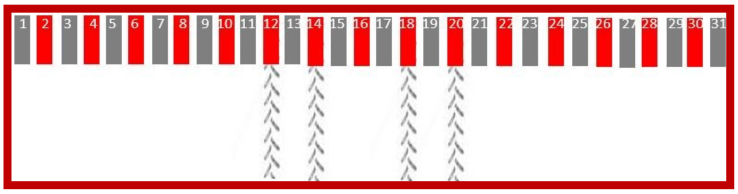
Planting operations were conducted with a variety of tractor tracks/wheels and planter tracks/wheels. The Case IH 380 CVT wheeled tractor, tracked planter treatment is depicted here.

OBSERVATIONS

The Ohio State Precision Ag Team conducted multiple Pinch Row Studies for corn. For 2017, the team decided to investigate the effects of planter track systems on soybeans.

Pinch Rows

Pinch row compaction is a common problem on every planter/tractor combination and especially bulk fill planters. Pinch rows are defined as any row that would be influenced due to compaction of the soil that falls within the tractor and/or implements footprint. To test this, there were 4 possible combinations including; wheeled tractor, tracked tractor, wheeled planter, tracked planter.



As seen above, Rows 11, 12, 13, 14, 15, 17, 18, 19, 20, 21 are affected by compaction from either/both the tractor and planter.

Growing Season

Throughout the growing season, the crop was monitored and no yield-limiting factors were observed. This field was under center pivot irrigation throughout the season. The field was scouted at multiple points throughout the growing season to investigate the effects of soil compaction on the "pinch rows" of the study.

The Case IH 380 CVT tracked tractor, wheeled planter treatment is shown above. This treatment yielded 81 bu/ac.

Tools of the Trade

FieldView™ Drive

Data Collection Device

The Drive collects operational data through the CAN port. This enables the producer to record data such as machine analytics, yield data, planting data, application data, and many other forms of ag data.

Harvesting

This study was harvested with the use of Climate FieldView Drive to ensure accurate data collection. In order to harvest the desired area of interest, a 40 ft header was used to harvest the exact pass width of each test strip.

SUMMARY

- All treatments were within 3 bushels. The treatments were statistically significant for treatment B and D, there was no clear distinction between the rest of the treatments.

PROJECT PARTNERS

Thank you to Beck's Hybrids for providing support for this project. Thank you to Camso for providing tracks for the planter. Special thanks to CNH Industrial for providing equipment through Evolution Ag and Wellington Implement for tractors and planter.

PROJECT CONTACT

For inquiries about this project, contact Andrew Klopfenstein—Senior Research Associate Engineer, Department of Food, Agricultural and Biological Engineering (klopfenstein.34@osu.edu).

Treatments	Yield (bu/ac)
Wheeled Tractor, Wheeled Planter	81 ab
Wheeled Tractor, Tracked Planter	82 a
Tracked Tractor, Wheeled Planter	81 ab
Tracked Tractor, Tracked Planter	79 ab
Treatment Means with the same letter are not significantly different according to Fisher's Protected Least Significant Differences (LSD) test at alpha = 0.1.	LSD: 2.39 CV: 2.63%

Planter Downforce in Strip-Till

OBJECTIVE

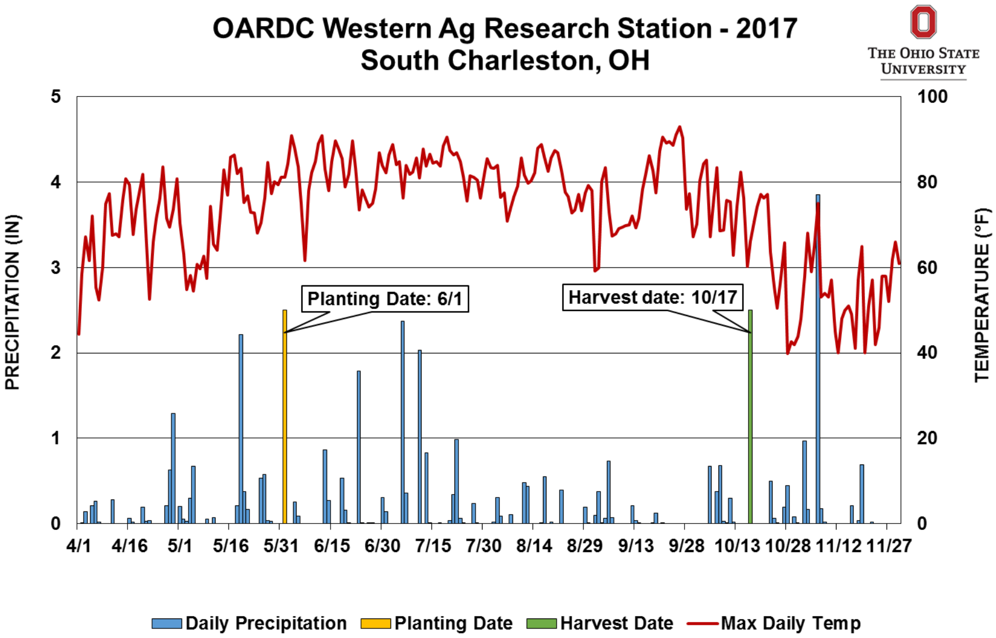
Understand planter downforce levels and the need to adjust when changing from no-till to strip-till management.

Western Agricultural Research Station

Clark County

STUDY INFORMATION

Planting Date	6/1/17
Harvest Date	10/17/17
Variety	P36T14R
Population	130,000 sds/ac
Acres	8.9
Treatments	5
Reps	3
Treatment Width	40 ft.
Tillage	Strip-Till
Herbicide	N/A
Pesticide	N/A
Previous Crop	Corn
Row Width	30 in.
Soil Type	Kokomo silty clay (48%) Strawn-Crosby complex (52%)



Weather Summary

Total	APR	MAY	JUN	JUL	AUG	Total
Precip (in)	3.39	5.52	4.30	7.44	2.62	23.27
Cumulative GDDs	235.0	571.0	1144.0	1900.0	2580.0	2580.0

STUDY DESIGN

Planter downforce systems have recently been adopted for modern planters. Substantial research has been done on recommended downforce (DF) levels for no-till managed fields, but little research for strip-till (ST) managed treatments. This study evaluated various downforce (DF) levels in strip-till treatments.

Treatments	Tillage	Applied Down-	Emergence
Control	No-Till	100	91.5
Optimal	Strip-Till	100	85.1
Heavy	Strip-Till	195	88.7
Light	Strip-Till	50	83.3

*Measured as additional load applied at gauge wheel

Planting into Strip-Tilled ground on 6/1/2017 at variable downforce levels.

OBSERVATIONS

Throughout the year, plant growth was monitored for any potential treatment differences. No yield limiting factors were observed except for minor headland weed pressure.

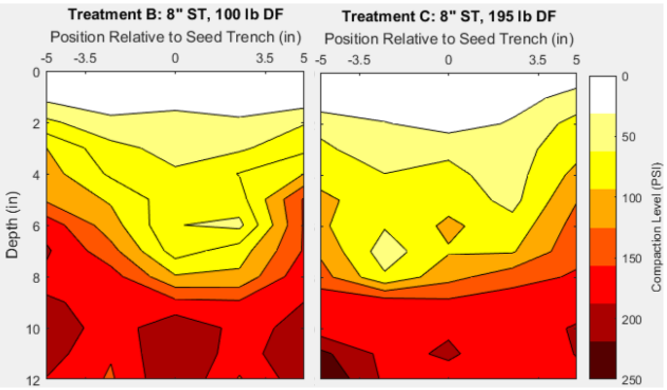
Emergence

Expected emergence results were observed between strip-till treatments with the “optimal” DF level having greater emergence over to Heavy and No DF treatments.

The largest deficit in emergence was observed for the 50 lb downforce treatment. Emergence generally increased with downforce settings.

Compaction

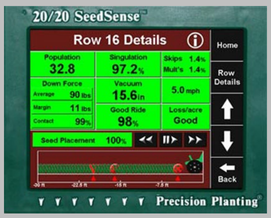
Penetrometer readings show strip-till was effective in reducing the level of compaction, and the highest level of applied DF (195 lb) did the best job of consolidating soil within the strip.



Tools of the Trade

Precision Planting 20/20

Planter control monitor



The 20/20 SeedSense Planting Monitor, when paired with a Precision Planting Downforce control system, allows the producer adjust downforce levels on a row-by-row basis. In this study, the monitor was used to set the downforce for each treatment.

SUMMARY

- No significant yield benefits to utilizing different downforce control systems, however it did appear to affect emergence.
- Highest downforce level achievable did not over compact the soil.
- Optimal (100 lb DF) provided the best emergence of the strip-till treatment.

KEY PARTNERS

The OSU Precision Ag team would like to thank the WARS staff for their assistance in growing season applications, and harvest logistics. Thanks to Pioneer for donating the seed. Orthman’s donation of the strip-till bar was also appreciated, along with planting and harvesting equipment from Evolution Ag.

PROJECT CONTACT

For inquiries about this project, contact Trey Colley, Graduate Research Assistant, Department of Food, Agricultural and Biological Engineering (Colley.65@osu.edu)

Treatments	Downforce (lbs)	Moisture (%)	Yield (bu/ac)
Control	100	12.1	61 a
Optimal	100	13.7	59 a
Heavy	195	13.4	61 a
Light	50	13.0	61 a

Treatment Means with the same letter are not significantly different according to Fisher’s Protected Least Significant Differences (LSD) test at alpha = 0.1.

Shank Depth in Strip-Till

OBJECTIVE

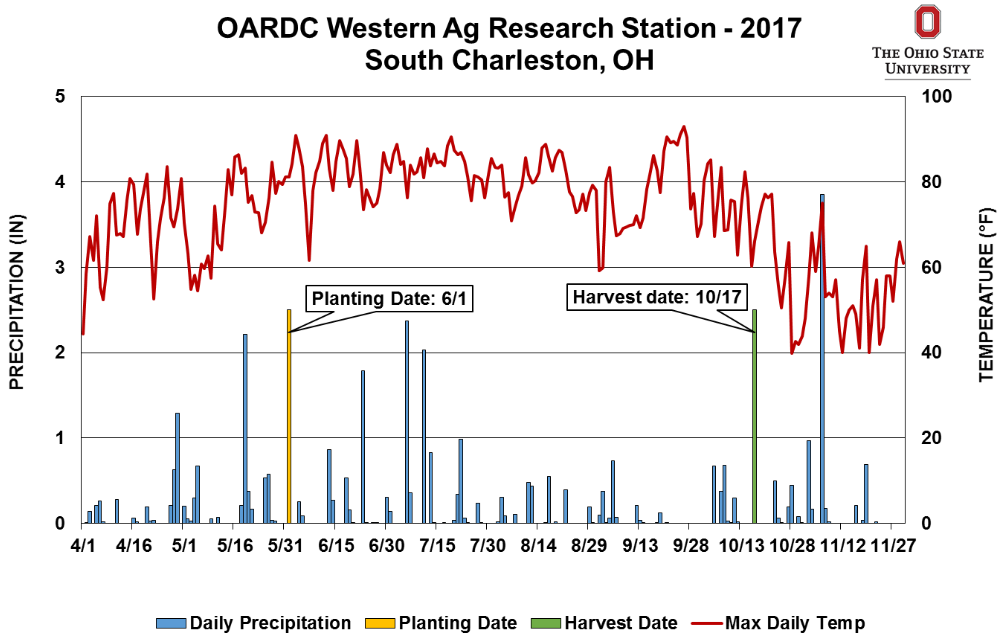
Understand the effect of shattering the compaction layer in strip-till managed fields.

Western Agricultural Research Station

Clark County

STUDY INFORMATION

Planting Date	6/1/17
Harvest Date	10/17/17
Variety	P36T14R
Population	130,000 sds/ac
Acres	18.1
Treatments	6
Reps	4
Treatment Width	40 ft.
Tillage	Strip-Till
Herbicide	Round-Up
Previous Crop	Corn
Row Width	30 in.
Soil Type	Kokomo silty clay (48%) Strawn-Crosby



Weather Summary

Total	APR	MAY	JUN	JUL	AUG	Total
Precip (in)	3.39	5.52	4.30	7.44	2.62	23.27
Cumulative GDDs	235.0	571.0	1144.0	1900.0	2580.0	2580.0

STUDY DESIGN

This study evaluated the effect of shattering the soil compaction layer in a strip-till managed system. The compacted layer was determined to reside at a depth of 8 inches. Shank depths of 4 and 8 inches were set to simulate either missing or shattering the existing compaction layer.

Treatments (in)	Tillage	Applied Downforce (lbs)*	Emergence (%)
Control	No-Till	100	87.9
4	Strip-Till	100	75.9
4	Strip-Till	50	86.9
8	Strip-Till	100	82.1
8	Strip-Till	50	76.9

Strip-Till was conducted with an 8 row Orthman 1tRIPr.

OBSERVATIONS

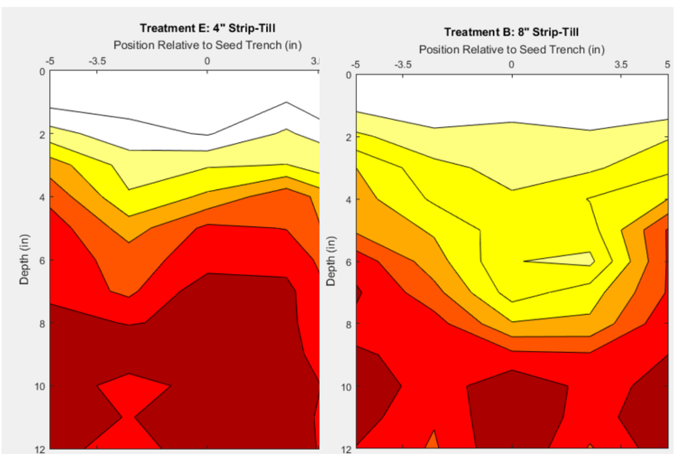
The 8 inch shank depth appropriately shattered the field's existing compaction layer. This was verified through excavation and assessment of plant uniformity. While no yield benefits were reported, several items were noted to affect plant growth throughout the growing season.

Emergence

Emergence was poor for the 4 inch shank depths. This was due to large soil clods formed by the soil when the shank missed the compacted layer, and pulled soil upward rather than shattering horizontally.

Compaction

Penetrometer readings were taken for all treatments. For the 8 inch depth, a good zone of loose soil was observed in the root zone area of the strips. The no-till treatments were observed to have the greatest compaction levels than all other treatments.



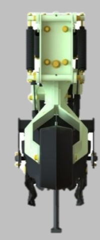
Compaction levels were not decreased in the 4 inch shank depth due to lack of shattering the existing compacted layer as was the case for the 8 inch depth.

Tools of the Trade

Orthman 1tRipr Row Unit

Shank-style strip-till unit

Adjustable heavy duty shank allows for ideal seedbed preparation. Can be equipped with dry, liquid, or anhydrous fertilizer attachments. Can place multiple products at varying depths



SUMMARY

- Proper shank depth settings drastically improve tillage performance.
- In this case, spring tillage led to a less than ideal seedbed preparation.
- No significant yield benefits were noted by any treatment.

KEY PARTNERS

The OSU Precision Ag team would like to thank the WARS staff for their assistance in growing season applications, and harvest logistics. Thanks to Pioneer for donating the seed. Orthman's donation of the strip-till bar was also appreciated, along with planting and harvesting equipment from Evolution Ag.

PROJECT CONTACT

For inquiries about this project, contact Trey Colley, Graduate Research Assistant, Department of Food, Agricultural and Biological Engineering (Colley.65@osu.edu)

Treatments (in)	Downforce (lbs)	Moisture (%)	Yield (bu/ac)
Control (No-Till)	100	12.1	61 a
4 in	100	12.8	60 a
4 in	50	13.0	61 a
8 in	100	13.7	61 a
8 in	50	13.0	61 a

Treatment Means with the same letter are not significantly different according to Fisher's Protected Least Significant Differences (LSD) test at alpha = 0.1.

Shank Depth in Strip-Till

OBJECTIVE

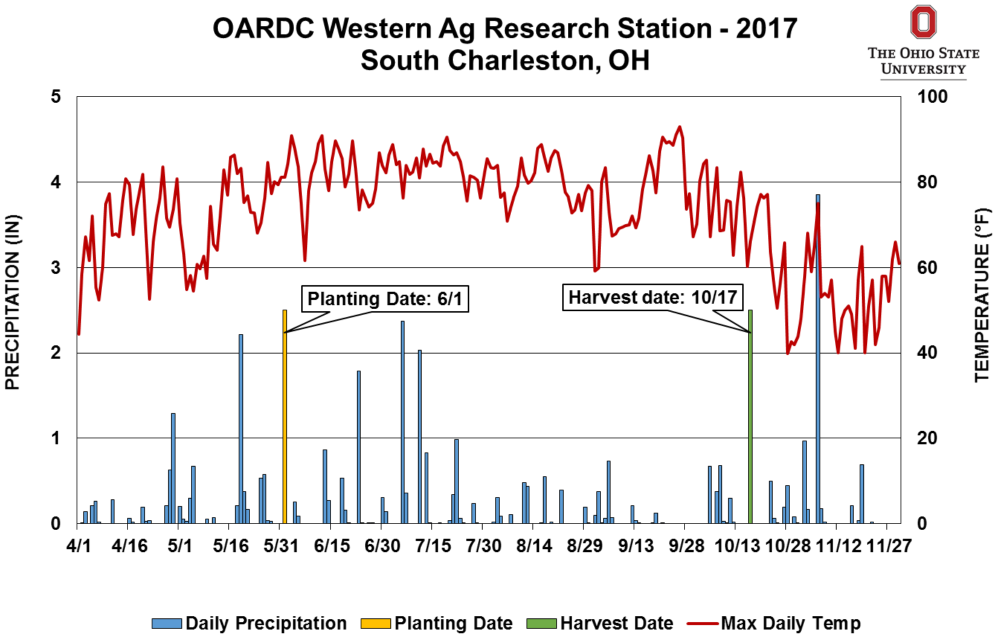
Understand the effect of shattering the compaction layer in strip-till managed fields.

Western Agricultural Research Station

Clark County

STUDY INFORMATION

Planting Date	6/1/17
Harvest Date	10/17/17
Variety	Pioneer P36T14R
Population	130,000 sds/ac
Acres	8.9
Treatments	5
Reps	3
Treatment Width	40 ft.
Tillage	Strip-Till
Herbicide	Round-Up
Previous Crop	Corn
Row Width	30 in.
Soil Type	Kokomo silty clay (48%) Strawn-Crosby



Weather Summary

Total	APR	MAY	JUN	JUL	AUG	Total
Precip (in)	3.39	5.52	4.30	7.44	2.62	23.27
Cumulative GDDs	235.0	571.0	1144.0	1900.0	2580.0	2580.0

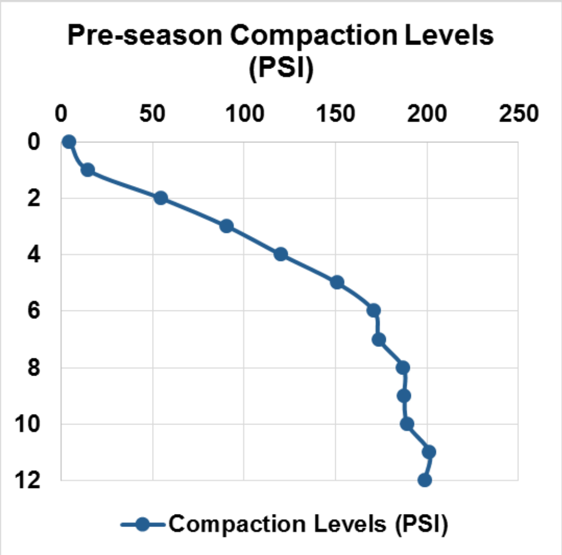
STUDY DESIGN

This study evaluated the effect of missing the soil compaction layer in a strip-till managed system. The compacted layer was determined to reside at a depth of 10 inches. Shank depths of 5 and 10 inches were set to compare shallow and proper tillage settings, respectively.

Study Treatments

Shank Depth (in)	Tillage	Fuel Rate (gal/hr)	Emergence (%)
Control	No-Till	-	91.5
10	Strip-Till	19.3	85.1
5*	Strip-Till	10.1	88.2

*Simulation of shallow shank depth during strip-till operation. Improper soil engagement led to undesirable seedbed preparation.



Soil compaction levels greater than 200 PSI are known to impede plant root growth. In this field, the compaction layer was at a10 in depth.

OBSERVATIONS

Tillage performance was greatly improved with proper shank depth setting. While fuel usage rate was essentially doubled, post-tillage compaction measurements confirmed that the compaction layer was sufficiently shattered at the 10 in shank depth setting.

Compaction

Penetrometer readings were taken for all treatments. For the 5 inch shank depth setting, it was observed that the shank did not penetrate the existing compacted layer and significant amounts of compaction were observed. For the 10 inch depth, a zone of loose soil was observed in the root zone area of the strips. The no-till treatments (not pictured) were observed to have greater compaction levels than all other treatments.

Fuel Consumption

Real-time telematics monitoring was used to record fuel usage rate of the Case IH 500 QuadTrac throughout the operation. It was found that tillage at 10 in used double the amount of fuel (gal/hr) than the 5 in depth.

Strip-Till was conducted with an 8 row Orthman 1tRIPr on a 500 QuadTrac Case IH Tractor.

Tools of the Trade

FieldScout SC-900

Soil Compaction Assessment Tool

The SC-900 Compaction Meter provides an easy way to identify the depth of the compacted layer in agricultural fields. In this study, the SC-900 was used to determine the shank depth of the strip-till. Shanks were then set at the proper depth to shatter the compacted layer.

SUMMARY

- Proper shank depth settings drastically improve tillage performance, but fuel usage was greatly increased.
- In this case, spring tillage led to a less than ideal seedbed preparation.
- No significant yield benefits were noted by any treatment.

KEY PARTNERS

The OSU Precision Ag team would like to thank the WARS staff for their assistance in growing season applications, and harvest logistics. Thanks to Pioneer for donating the seed. Orthman's donation of the strip-till bar was also appreciated, along with planting and harvesting equipment from Evolution Ag.

PROJECT CONTACT

For inquiries about this project, contact Trey Colley, Graduate Research Assistant, Department of Food, Agricultural and Biological Engineering (Colley.65@osu.edu)

Treatments (in)	Fuel Rate (gal/hr)	Moisture (%)	Yield (bu/ac)
Control (No-Till)	-	10.9	57 a
10	19.3	10.9	55 a
5	10.1	10.9	54 a

Treatment Means with the same letter are not significantly different according to Fisher's Protected Least Significant Differences (LSD) test at alpha = 0.1.

Seeding Rate Trials—Summary

OBJECTIVE

Understand the yield impact of varying soybean seeding rates within Ohio considering in-field variability and cultural practices implemented. Information from this trial will be used to improve management recommendations for growers throughout Ohio understand how variable-rate seeding may impact field-by-field profit.

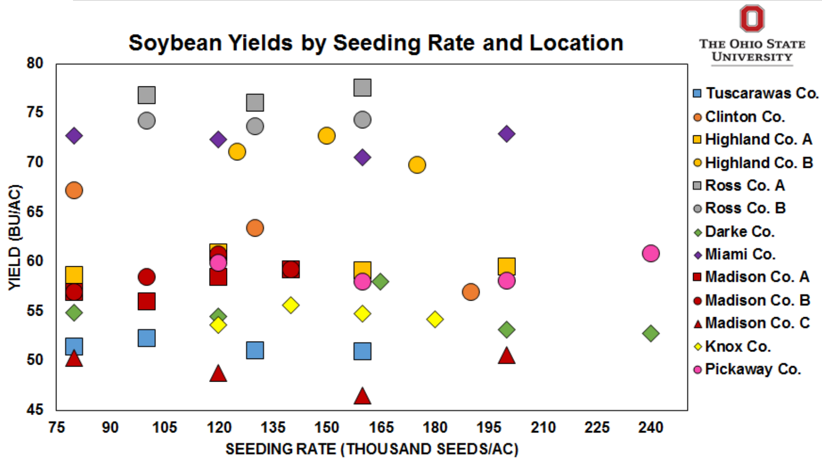
STUDY DESIGN

The primary recommendations for seeding rates in Ohio are determined by target final stands and "average" soil productivity. Variable-rate seeding prescriptions have the potential to better match seeding rate to productivity zones in an effort to optimize profits. Field studies were implemented in a strip-trial format and replicated at least three times within the fields. Results for individual sites plus an aggregated pool analyses was conducted.

Planter equipped with variable-rate seeding capabilities.

Tools of the Trade

Sound information and data on soybean variety selection and associated seeding rate for 1) planter or seeder, and 2) recommended final population.



SUMMARY

- Across all sites, the average soybean emergence was 87% with individual sites ranging between 78% to 98%.
- Variation in soybean yield was primarily caused by differences in location and not differences in seeding rates in 2017.
- There was a significant response to soybean seeding rate at 5 out of 13 sites in 2017.

Spatial analyses will be used to uncover the causes of yield variation between sites and determine possible responses to seeding rate and emergence based on in-field variability at each site.

EXAMPLE FIELD LAYOUT

To maximize learning, a minimum of five different seeding rates should be compared. More rates can be added, if adequate space is available. The seeding rates compared in the trial need to be different enough to have the potential to affect yield, a minimum difference of 40,000 seeds/acre between each treatment is recommended. It may be necessary to adjust these seeding rates slightly based on your equipment capabilities.

Proper experimental design is important to ensure the validity of the yield results at the end of the season. Plot replication and randomization make it possible for statistical analysis to account for the natural field variation that occurs. For this study, a minimum of three replications should be used and four replications are recommended. Plots should be randomized within each replication to eliminate bias due to plot order.

Planter Pass	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Replication			1					2					3					4		
Plot ID	101	102	103	104	105	201	202	203	204	205	301	302	303	304	305	401	402	403	404	405
Description	80k	200k	160k	240k	120k	160k	120k	80k	120k	240k	120k	240k	80k	160k	200k	200k	240k	120k	80k	160k

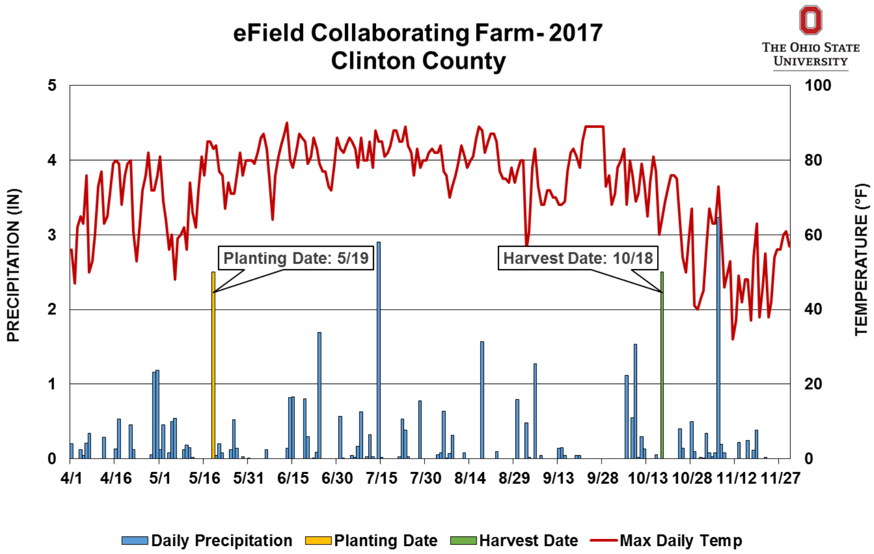
STUDY INFORMATION

Planting Date	5/19/2017
Harvest Date	10/18/2017
Variety	P37T09L
Population	Treatments
Acres	9.6
Treatments	3
Reps	4
Treatment Width	40 ft.
Tillage	Conventional
Herbicide	N/A
Pesticide	N/A
Previous Crop	Corn
Row Spacing	15 in.
Soil Type	Treaty silt loam (53%) Xenia silt loam (33%) Fincastle silt loam (3%)

eFields Collaborating Farm

OSU Extension

Clinton County



Weather Summary

Total	APR	MAY	JUN	JUL	AUG	Total
Precip (in)	4.83	3.32	4.80	6.49	3.70	23.14
Cumulative GDDs	248.0	614.0	1225.0	1941.0	2536.0	2536.0

PROJECT CONTACT

For inquiries about this project, contact Elizabeth Hawkins, Assistant Professor, Field Specialist, Department of Extension (hawkins.301@osu.edu).

Treatments (sds/ac)	Avg. Emergence (plants/ac)	Yield (bu/ac)
80,000	63,750	67 a
130,000	105,250	63 a
190,000	156,625	57 b
Treatment Means with the same letter are not significantly different according to Fisher's Protected Least Significant Differences (LSD) test at alpha = 0.1.		LSD: 5.16 CV: 6.00%

Seeding Rate Trials

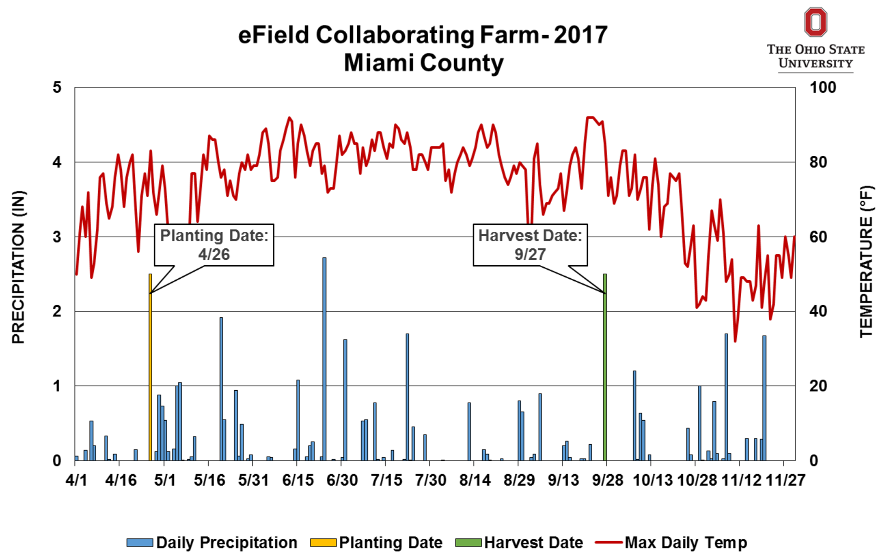
STUDY INFORMATION

Planting Date	4/26/2017
Harvest Date	9/27/2017
Variety	Ebberts 368RR2X
Population	Treatments
Acres	44.0
Treatments	4
Reps	3
Treatment Width	60 ft.
Tillage	Conventional
Herbicide	N/A
Pesticide	N/A
Previous Crop	Corn
Row Spacing	15 in.
Soil Type	Eldean loam (58%) Westland silty clay loam (19%)

eFields Collaborating Farm

OSU Extension

Miami County



Weather Summary

Total	APR	MAY	JUN	JUL	AUG	Total
Precip (in)	3.25	7.34	4.66	6.21	2.52	23.98
Cumulative GDDs	273.0	672.0	1326.0	2090.0	2758.0	2758.0

PROJECT CONTACT

For inquiries about this project, contact Elizabeth Hawkins, Assistant Professor, Field Specialist, Department of Extension (hawkins.301@osu.edu).

Treatments (sds/ac)	Avg. Emergence (plants/ac)	Yield (bu/ac)
80,000	72,504	73 a
120,000	117,089	72 a
160,000	144,642	71 a
200,000	187,865	73 a
Treatment Means with the same letter are not significantly different according to Fisher's Protected Least Significant Differences (LSD) test at alpha = 0.1.		LSD: *not significant CV: 10.24%

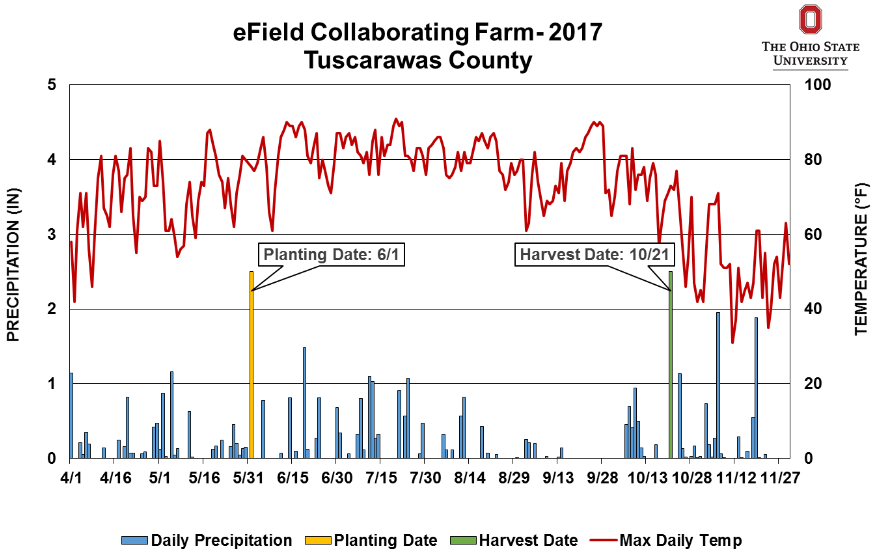
STUDY INFORMATION

Planting Date	6/1/2017
Harvest Date	10/212017
Variety	Hubner 3213
Population	Treatments
Acres	30.1
Treatments	4
Reps	3
Treatment Width	40 ft.
Tillage	No-Till
Herbicide	N/A
Pesticide	N/A
Previous Crop	Corn
Row Spacing	15 in.
Soil Type	Tioga loam (43%) Chili silt loam and gravel loam (20%)

eFields Collaborating Farm

OSU Extension

Tuscarawas County



Weather Summary

Total	APR	MAY	JUN	JUL	AUG	Total
Precip (in)	4.48	4.66	5.45	7.43	2.49	24.51
Cumulative GDDs	215.0	546.0	1118.0	1841.0	2461.0	2461.0

PROJECT CONTACT

For inquiries about this project, contact Elizabeth Hawkins, Assistant Professor, Field Specialist, Department of Extension (hawkins.301@osu.edu).

Treatments (sds/ac)	Avg. Emergence (plants/ac)	Yield (bu/ac)
80,000	76,533	51 a
100,000	94,667	52 a
130,000	124,800	51 a
160,000	153,066	51 a

Treatment Means with the same letter are not significantly different according to Fisher's Protected Least Significant Differences (LSD) test at alpha = 0.1.

LSD: *not significant

CV: 2.24%

Seeding Rate Trials

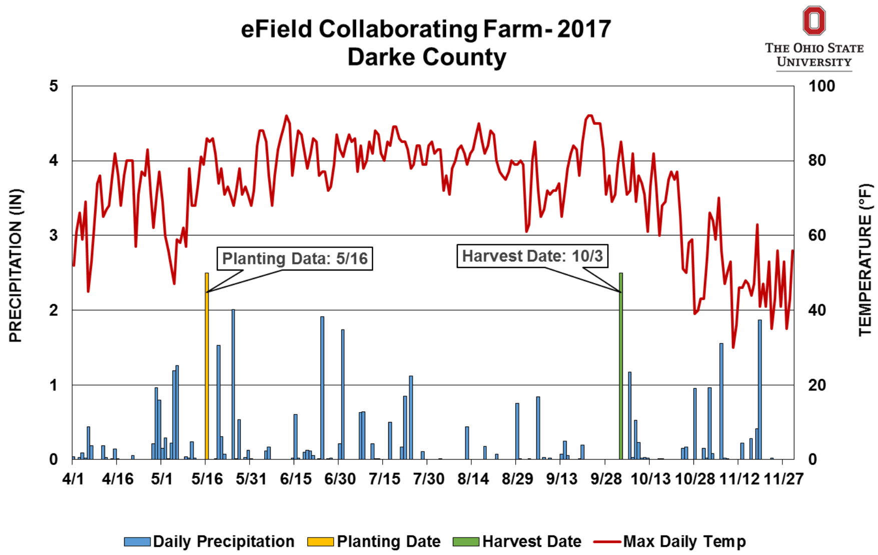
eFields Collaborating Farm

OSU Extension

Darke County

STUDY INFORMATION

Planting Date	5/16/2017
Harvest Date	10/3/2017
Variety	Asgrow 3832 and 38X2
Population	Treatments
Acres	5.0
Treatments	5
Reps	3
Treatment Width	30 ft
Tillage	No-Till
Herbicide	Roundup,2-4D LV6, Rowel
Pesticide	None
Previous Crop	Corn
Row Spacing	15 in.
Soil Type	Crosby silt loam (64%) Brookston silty clay loam (33%) Miamian



Weather Summary

Total	APR	MAY	JUN	JUL	AUG	Total
Precip (in)	3.45	8.08	3.49	6.91	1.46	23.39
Cumulative GDDs	265.0	595.0	1237.0	1978.0	2590.0	2590.0

PROJECT CONTACT

For inquiries about this project, contact Elizabeth Hawkins, Assistant Professor, Field Specialist, Department of Extension (hawkins.301@osu.edu).

Treatments (sds/ac)	Avg. Emergence (plants/ac)	Yield (bu/ac)
80,000	N/A	54 a
120,000	N/A	54 a
160,000	N/A	58 a
200,000	N/A	54 a
240,000	N/A	54 a
Treatment Means with the same letter are not significantly different according to Fisher's Protected Least Significant Differences (LSD) test at alpha = 0.1.		LSD: *not significant CV: 4.73%

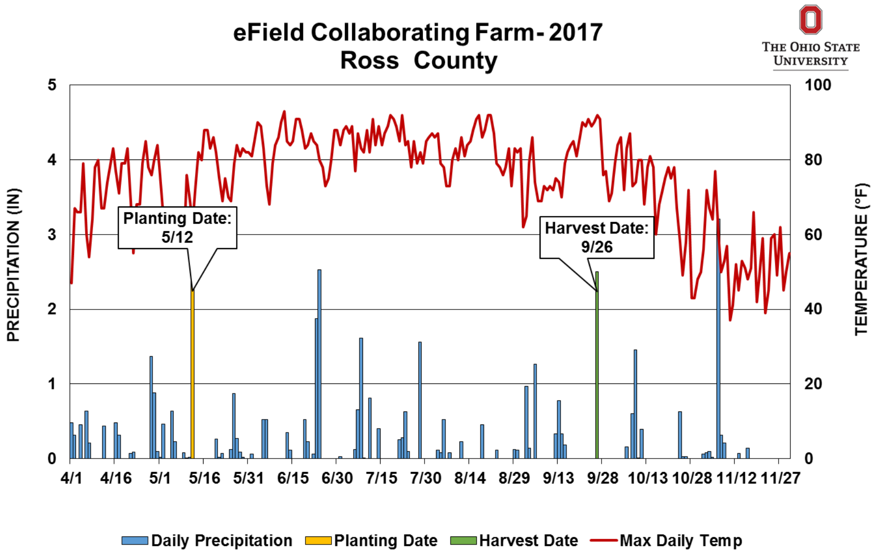
eFields Collaborating Farm

OSU Extension

Ross County – A

STUDY INFORMATION

Planting Date	5/12/2017
Harvest Date	9/26/2017
Variety	Asgrow 36X6
Population	Treatments
Acres	6.6
Treatments	3
Reps	3
Treatment Width	30 ft.
Tillage	Conventional
Herbicide	N/A
Pesticide	N/A
Previous Crop	Corn
Row Spacing	15 in.
Soil Type	Pike silt loam (96%) Negley loam (4%)



Weather Summary

Total	APR	MAY	JUN	JUL	AUG	Total
Precip (in)	5.83	3.18	6.77	6.45	1.81	24.04
Cumulative GDDs	325.0	767.0	1447.0	2241.0	2933.0	2933.0

PROJECT CONTACT

For inquiries about this project, contact Elizabeth Hawkins, Assistant Professor, Field Specialist, Department of Extension (hawkins.301@osu.edu).

Treatments (sds/ac)	Avg. Emergence (plants/ac)	Yield (bu/ac)
100,000	76,675	77 a
130,000	92,670	76 a
160,000	95,000	78 a
Treatment Means with the same letter are not significantly different according to Fisher's Protected Least Significant Differences (LSD) test at alpha = 0.1.		LSD: *not significant CV: 2.01%

Seeding Rate Trials

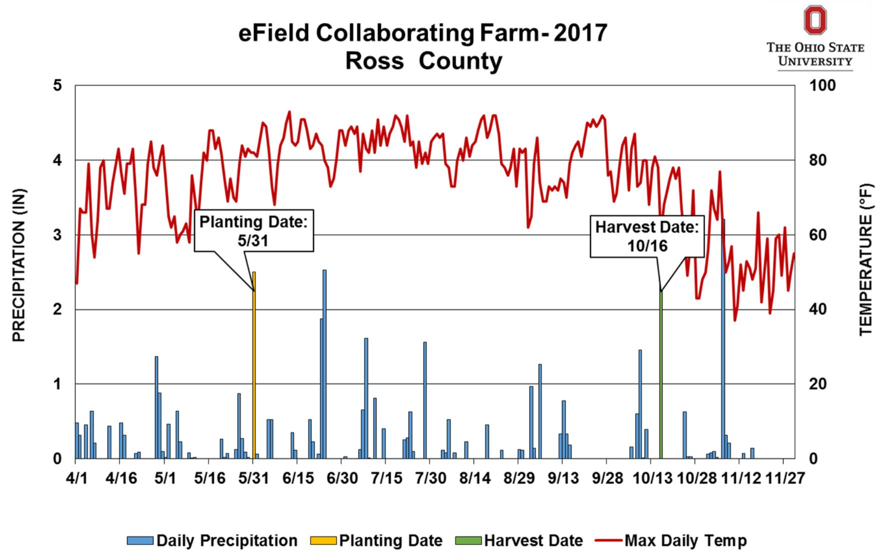
eFields Collaborating Farm

OSU Extension

Ross County – B

STUDY INFORMATION

Planting Date	5/31/2017
Harvest Date	10/16/2017
Variety	Becks' 387R4
Population	Treatments
Acres	17.9
Treatments	3
Reps	3
Treatment Width	30 ft.
Tillage	Conventional
Herbicide	N/A
Pesticide	N/A
Previous Crop	Corn
Row Spacing	15 in.
Soil Type	Gessie silt loam (71%) Ross silt loam (25%) Ockley loam (4%)



Weather Summary

Total	APR	MAY	JUN	JUL	AUG	Total
Precip (in)	5.83	3.18	6.77	6.45	1.81	24.04
Cumulative GDDs	325.0	767.0	1447.0	2241.0	2933.0	2933.0

PROJECT CONTACT

For inquiries about this project, contact Elizabeth Hawkins, Assistant Professor, Field Specialist, Department of Extension (hawkins.301@osu.edu).

Treatments (sds/ac)	Avg. Emergence (plants/ac)	Yield (bu/ac)
100,000	85,333	74 a
130,000	107,667	74 a
160,000	132,000	74 a
Treatment Means with the same letter are not significantly different according to Fisher's Protected Least Significant Differences (LSD) test at alpha = 0.1.		LSD: *not significant CV: 1.97%

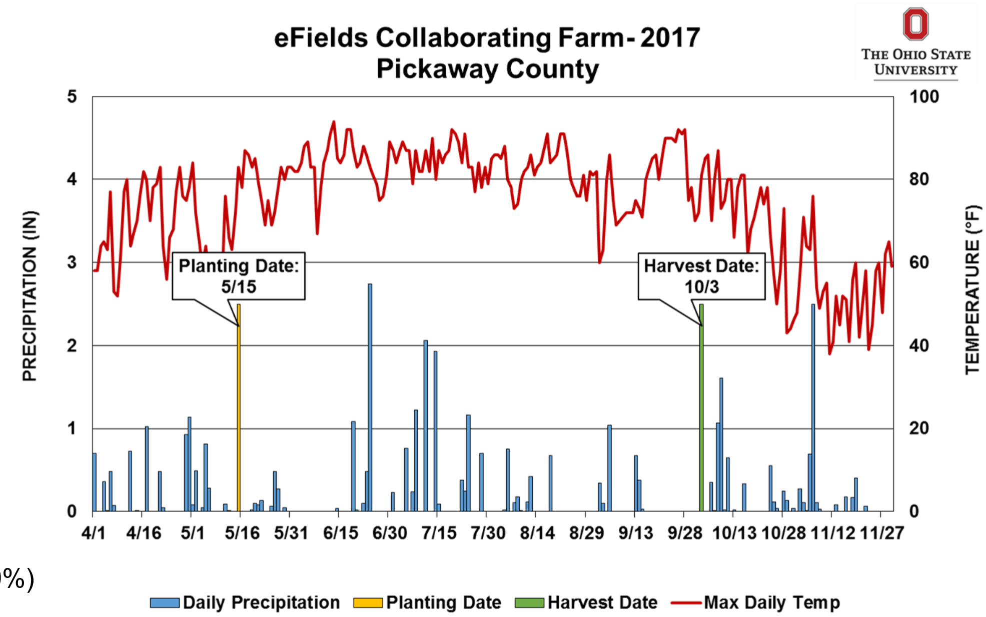
eFields Collaborating Farm

OSU Extension

Pickaway County

STUDY INFORMATION

Planting Date	5/15/2017
Harvest Date	10/03/2017
Variety	AG39x7
Population	Treatments
Acres	19
Treatments	4
Reps	3
Treatment Width	38.75 ft.
Tillage	No-till
Herbicide	N/A
Pesticide	N/A
Previous Crop	Corn
Row Spacing	15 in.
Soil Type	Crosby silt loam (64%) Kokomo silty clay loam (9%) Miamian-Lewisburg silt loam (14%) Corwin silt loam (13%)



Weather Summary

Total	APR	MAY	JUN	JUL	AUG	Total
Precip (in)	5.98	3.00	4.46	9.02	2.28	24.74
Cumulative GDDs	233.0	604.0	1266.0	2049.0	2738.0	2738.0

PROJECT CONTACT

For inquiries about this project, contact Elizabeth Hawkins, Assistant Professor, Field Specialist, Department of Extension (hawkins.301@osu.edu).

Treatments (sds/ac)	Avg. Emergence (plants/ac)	Yield (bu/ac)
120,000	N/A	60 a
160,000	N/A	58 b
200,000	N/A	58 b
240,000	N/A	61 a
Treatment Means with the same letter are not significantly different according to Fisher's Protected Least Significant Differences (LSD) test at alpha = 0.1.		LSD: 1.36 CV: 1.51%

Seeding Rate Trials

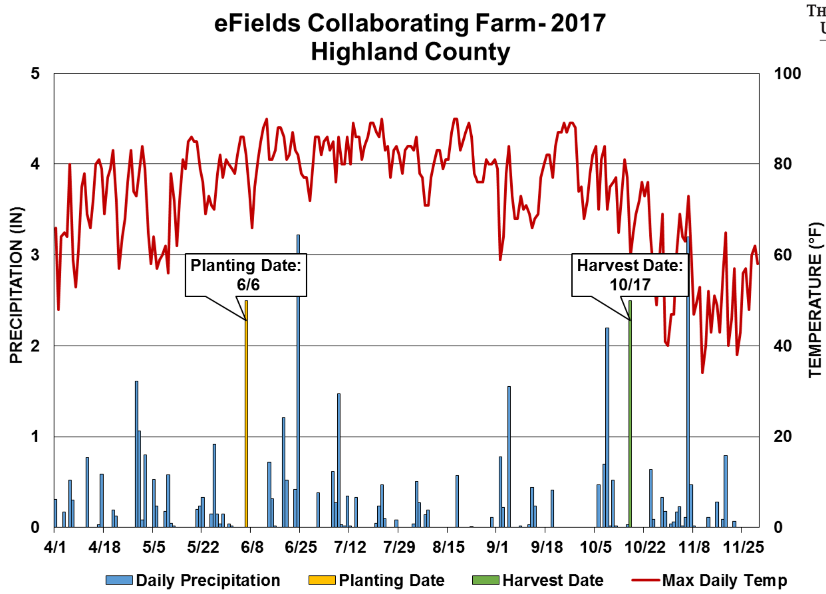
eFields Collaborating Farm

OSU Extension

Highland County – A

STUDY INFORMATION

Planting Date	6/6/2017
Harvest Date	10/17/2017
Variety	3810GRNT
Population	Treatments
Acres	17.5
Treatments	4
Reps	3
Treatment Width	30 ft.
Tillage	No-Till
Herbicide	N/A
Pesticide	N/A
Previous Crop	Corn
Row Spacing	15 in.
Soil Type	Clermont silt loam (45%) Westboro Schaffer silt loam (55%)



Weather Summary

Total	APR	MAY	JUN	JUL	AUG	Total
Precip (in)	5.68	4.70	6.83	4.43	1.84	23.48
Cumulative GDDs	280.0	693.0	1273.0	1999.0	2519.0	2519.0

PROJECT CONTACT

For inquiries about this project, contact Elizabeth Hawkins, Assistant Professor, Field Specialist, Department of Extension (hawkins.301@osu.edu).

Treatments (sds/ac)	Avg. Emergence (plants/ac)	Yield (bu/ac)
80,000	42,330	59 a
120,000	65,000	61 a
160,000	89,330	60 a
200,000	130,000	59 a

Treatment Means with the same letter are not significantly different according to Fisher's Protected Least Significant Differences (LSD) test at alpha = 0.1.

LSD: *not significant

CV: 2.84%

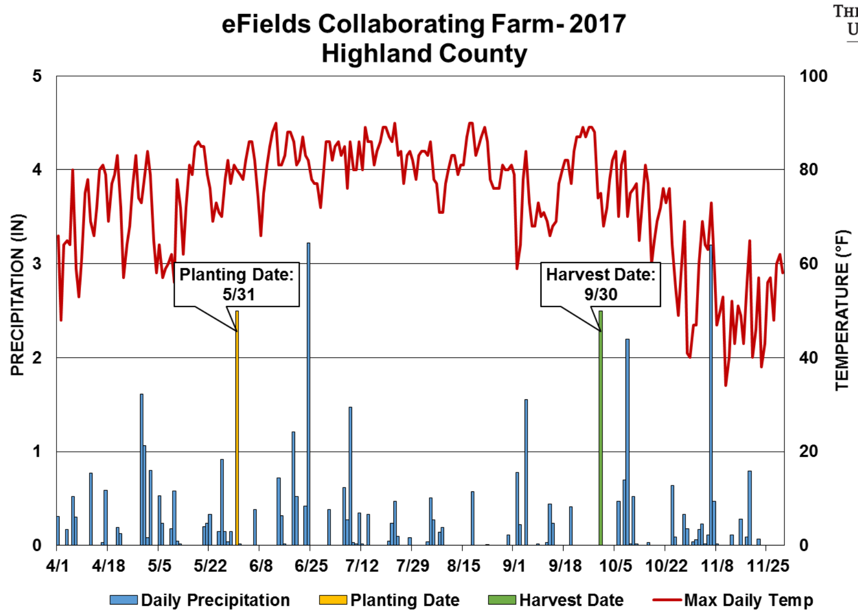
eFields Collaborating Farm

OSU Extension

Highland County—B

STUDY INFORMATION

Planting Date	5/31/2017
Harvest Date	9/30/2017
Variety	Becks' 387R4
Population	Treatments
Acres	17.9
Treatments	3
Reps	4
Treatment Width	80 ft.
Tillage	Conventional
Herbicide	Fall 2016 - 2,4-D and Dicamba Spring 2017 - Powermax, Sharpen, Metribuzin, Canopy Summer 2017 - Powermax, AMS
Pesticide	N/A
Previous Crop	Corn
Row Spacing	15 in.
Soil Type	Clermont silt loam (45%) Westboro Schaffer silt loam (55%)



Weather Summary

Total	APR	MAY	JUN	JUL	AUG	Total
Precip (in)	5.68	4.70	6.83	4.43	1.84	23.48
Cumulative GDDs	280.0	693.0	1273.0	1999.0	2519.0	2519.0

PROJECT CONTACT

For inquiries about this project, contact Elizabeth Hawkins, Assistant Professor, Field Specialist, Department of Extension (hawkins.301@osu.edu).

Treatments (sds/ac)	Avg. Emergence (plants/ac)	Yield (bu/ac)
125,000	112,250	71 a
150,000	135,000	73 b
175,000	156,000	70 a
Treatment Means with the same letter are not significantly different according to Fisher's Protected Least Significant Differences (LSD) test at alpha = 0.1.		LSD: 1.87 CV: 2.03%

Seeding Rate Trials

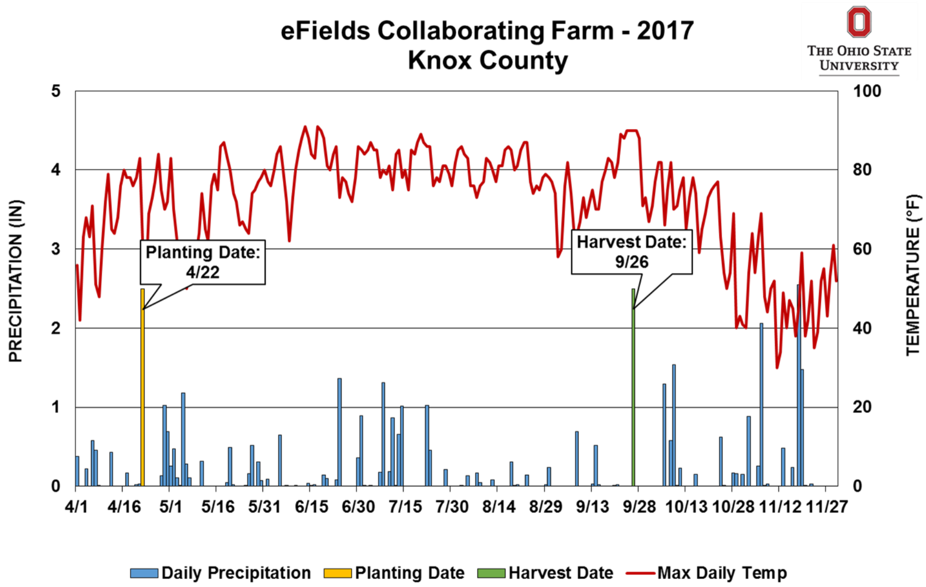
STUDY INFORMATION

Planting Date	4/22/2017
Harvest Date	9/26/2017
Variety	P28T62
Population	Treatments
Acres	4.1
Treatments	4
Reps	3
Treatment Width	40 ft.
Tillage	No-Til
Herbicide	Fall (2016) Metribuzin/ Canopy/2,4-D Pre - Weedmaster/ Glyphosate Post - Glyphosate
Pesticide	N/A
Previous Crop	Corn
Row Spacing	15 in.
Soil Type	Bennington silt loam Centerburg silt loam Condit silt loam

eFields Collaborating Farm

OSU Extension

Knox County



Weather Summary

Total	APR	MAY	JUN	JUL	AUG	Total
Precip (in)	4.19	4.37	2.87	6.83	1.18	19.44
Cumulative GDDs	232.0	552.0	1128.0	1812.0	2384.0	2384.0

PROJECT CONTACT

For inquiries about this project, contact Elizabeth Hawkins, Assistant Professor, Field Specialist, Department of Extension (hawkins.301@osu.edu).

Treatments (sds/ac)	Avg. Emergence (plants/ac)	Yield (bu/ac)
120,000	112,200	54 a
140,000	129,200	56 a
160,000	146,200	55 a
180,000	166,600	54 a
Treatment Means with the same letter are not significantly different according to Fisher's Protected Least Significant Differences (LSD) test at alpha = 0.1.		LSD: 3.8 CV: 4.39%

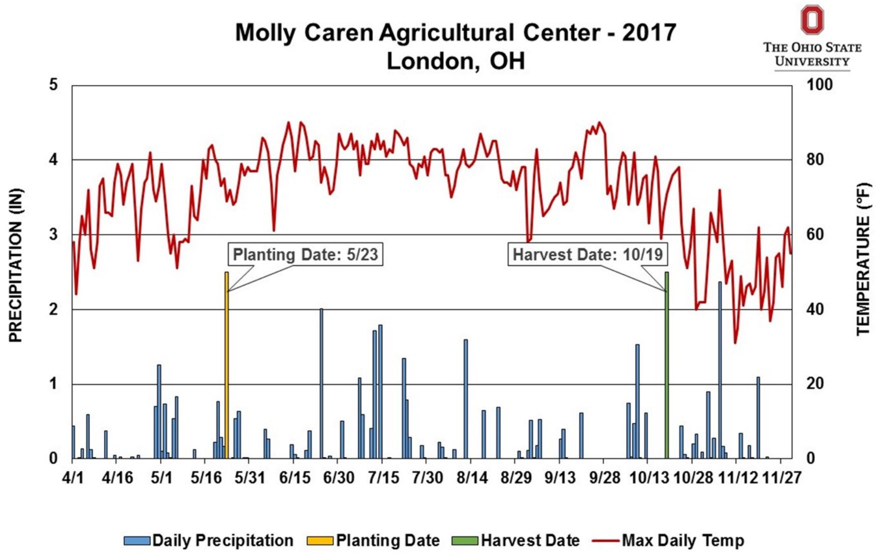
SOYBEAN

STUDY INFORMATION

Planting Date	5/23/2017
Harvest Date	10/19/2017
Variety	AG3536
Population	Treatments
Acres	45.0
Treatments	5
Reps	4
Treatment Width	40 ft.
Tillage	Conventional
Herbicide	N/A
Pesticide	N/A
Previous Crop	Corn
Row Spacing	15 in.
Soil Type	Kokomo silty clay loam (44%) Crosby—Lewisburg silt loam (50%)

Molly Caren Agricultural Center

Madison County—A



Weather Summary

Total	APR	MAY	JUN	JUL	AUG	Total
Precip (in)	3.80	5.07	3.48	8.72	2.65	23.72
Cumulative GDDs	216.0	551.0	1124.0	1823.0	2404.0	2404.0

PROJECT CONTACT

For inquiries about this project, contact Elizabeth Hawkins, Assistant Professor, Field Specialist, Department of Extension (hawkins.301@osu.edu).

Treatments (sds/ac)	Avg. Emergence (plants/ac)	Yield (bu/ac)
60,000	N/A	53 a
80,000	N/A	57 ab
100,000	N/A	59 b
120,000	N/A	61 b
140,000	N/A	59 b
Treatment Means with the same letter are not significantly different according to Fisher's Protected Least Significant Differences (LSD) test at alpha = 0.1.		LSD: 4.11 CV: 5.66%

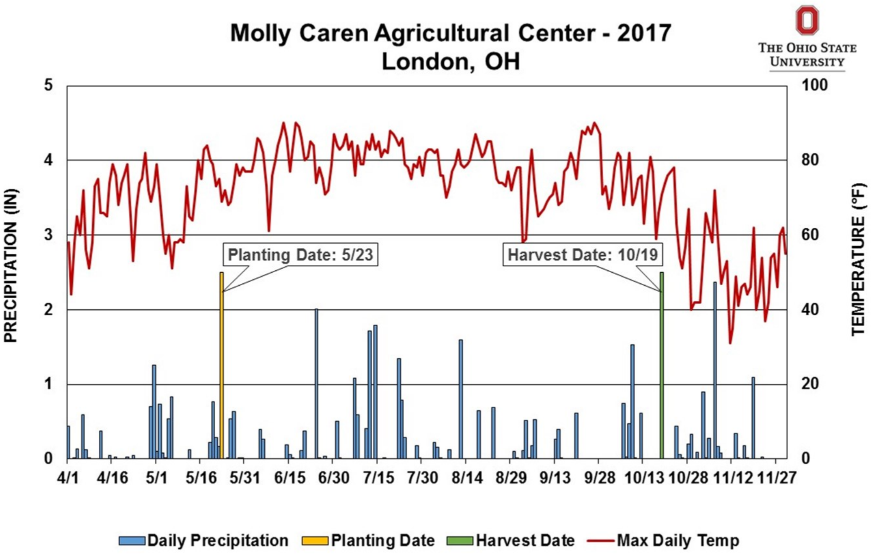
Seeding Rate Trials

STUDY INFORMATION

Planting Date	5/23/2017
Harvest Date	10/19/2017
Variety	AG3536
Population	Treatments
Acres	45.0
Treatments	5
Reps	4
Treatment Width	40 ft.
Tillage	Conventional
Herbicide	N/A
Pesticide	N/A
Previous Crop	Corn
Row Spacing	15 in.
Soil Type	Kokomo silty clay loam (44%) Crosby—Lewisburg silt loam (50%)

Molly Caren Agricultural Center

Madison County—B



Weather Summary

Total	APR	MAY	JUN	JUL	AUG	Total
Precip (in)	3.80	5.07	3.48	8.72	2.65	23.72
Cumulative GDDs	216.0	551.0	1124.0	1823.0	2404.0	2404.0

PROJECT CONTACT

For inquiries about this project, contact Elizabeth Hawkins, Assistant Professor, Field Specialist, Department of Extension (hawkins.301@osu.edu).

Treatments (sds/ac)	Avg. Emergence (plants/ac)	Yield (bu/ac)
60,000	N/A	55 a
80,000	N/A	57 ab
100,000	N/A	56 ab
120,000	N/A	58 ab
140,000	N/A	59 b

Treatment Means with the same letter are not significantly different according to Fisher's Protected Least Significant Differences (LSD) test at alpha = 0.1.

LSD: 3.67

CV: 5.11%

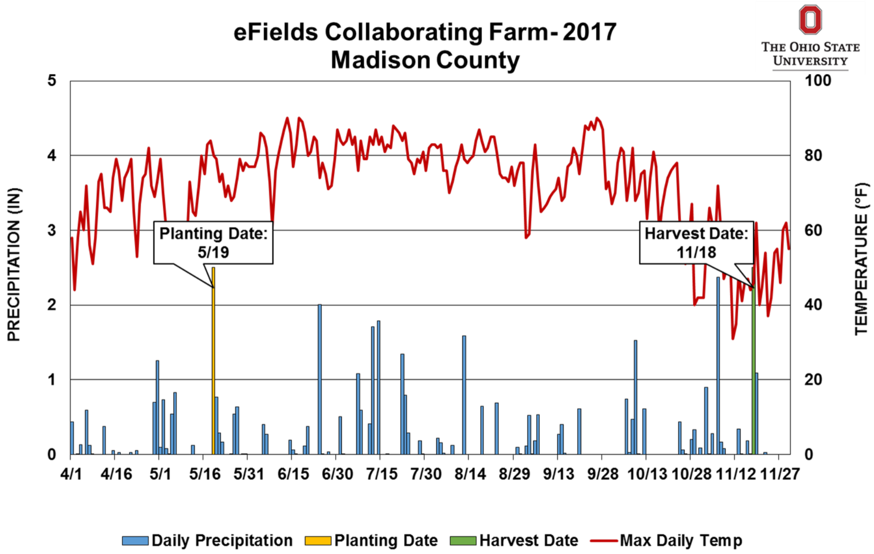
STUDY INFORMATION

Planting Date	5/19/2017
Harvest Date	11/18/2017
Variety	Stewart 3412R2
Population	Treatments
Acres	8.3
Treatments	4
Reps	3
Treatment Width	30 ft.
Tillage	No-Till
Herbicide	Round-Up
Pesticide	N/A
Previous Crop	Corn
Row Spacing	30 in.
Soil Type	Kokomo silty clay (56%) Lewisburg-Celina silt loam (44%)

eFields Collaborating Farm

OSU Extension

Madison County—C



Weather Summary

Total	APR	MAY	JUN	JUL	AUG	Total
Precip (in)	3.80	5.07	3.48	8.72	2.65	23.72
Cumulative GDDs	216.0	551.0	1124.0	1823.0	2404.0	2404.0

PROJECT CONTACT

For inquiries about this project, contact Elizabeth Hawkins, Assistant Professor, Field Specialist, Department of Extension (hawkins.301@osu.edu).

Treatments (sds/ac)	Avg. Emergence (plants/ac)	Yield (bu/ac)
80,000	78,333	50 a
120,000	96,667	49 a
160,000	126,667	47 a
200,000	173,333	51 a
Treatment Means with the same letter are not significantly different according to Fisher's Protected Least Significant Differences (LSD) test at alpha = 0.1.		LSD: 21.2 CV: 28.5%

Distribution Uniformity of Fertilizers

OBJECTIVE

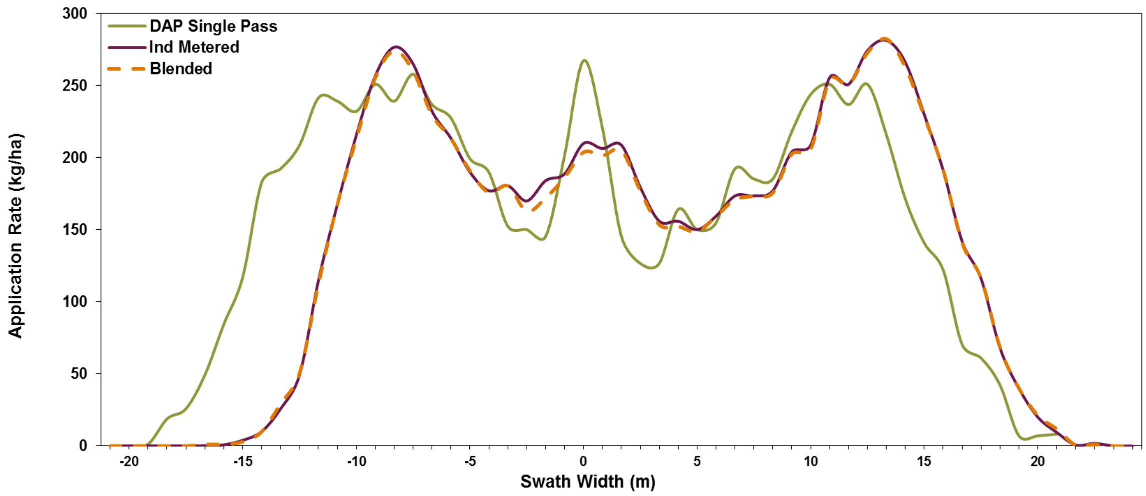
Evaluate possible Phosphorus pattern differences whether metered alone, independently with Potassium, or in a blend.

Department of Food, Agricultural, and Biological Engineering

Franklin County

OBSERVATIONS

Fertilizer properties, such as size, shape, and density, have a large effect on the observable spread pattern across a field. It is important to consider these changes in product properties and blends as an applicator travels across the field. In order to achieve maximum efficiencies, spreader settings must change as the source or rate changes. To test the metering type, the same fertilizers were spread by various metering methods including (1) independently metered fertilizers, where fertilizers are kept separate until being metered onto the spinner-disc and (2) blended fertilizers, where the fertilizer is blended in the bin.



Observed spread patterns for DAP fertilizers showed little difference in uniformity by metering type.

Test 1: DAP Only, Single-pass Mean Patterns

Spread patterns for the DAP component of all three fertilizer loadings were analyzed for uniformity. The DAP component application rates for the DAP only source are displayed above in Figure 1. For the target application rate of 252 kg/ha, a “W” shaped spread pattern was observed within the 30 m target swath.

STUDY DESIGN

All spread pattern analyses were conducted in accordance with ASABE S341.4 & ISO 5690-1:1985 standards. Collection pan spacing was 2.5 ft and test areas were extended to twice the width of the target swath. A New Leader L428G4 MultApplier Bed self-propelled spreader was used for all tests. Figures 1 and 2 illustrate the pan testing layout, bin configurations, and test loadings, respectively.

Standard Pan Testing Layout

All spreader parameters outside of those being tested were held constant.

Speed	Divider Height
750	8.25

Split Bin set up with DAP/ Potash loaded.

OBSERVATIONS CONT.

Test 2: Dual Product, Independently Metered

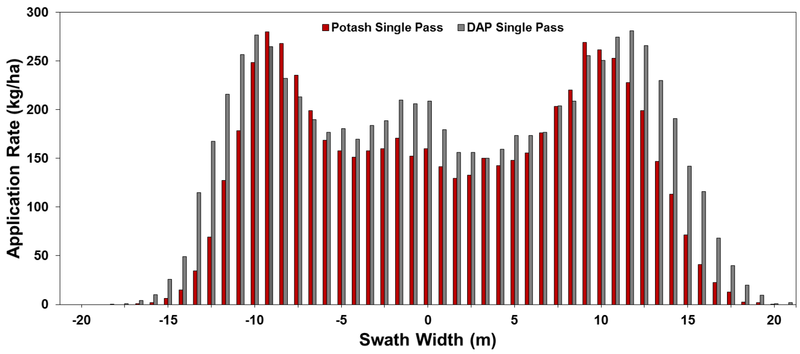
The graphs below display the observed application for both DAP and Potash based on metering type. The recorded application rates were divided into each fertilizer constituent from the blended fertilizer source. Generally, the DAP components of the fertilizer source were spread further away from the centerline of the spreader, while the potash components were found closer to the centerline of the spreader. This effect may be attributed to the intrinsic ballistic properties of the fertilizer blend rather than preset spreader settings. Of the 55 collection pans in the test, only five of them met the desired ratio of P_2O_5:K_2O.

Tools of the Trade

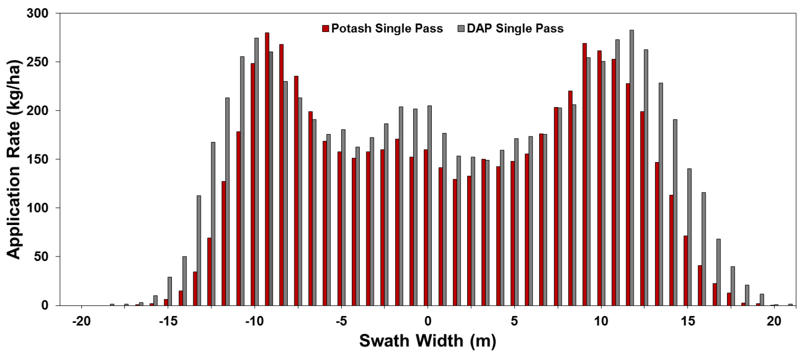
Standard Collection Pan

Pan testing not only evaluates the degree of uniformity across the swath, but also determines the type of spread pattern, the effective swath width, and the rate of application. It is important to follow the ASABE and ISO Standards when testing for spread uniformity.

2. Pan Collection Analysis: Independently Metered



3. Pan Collection Analysis: Blended



Individual constituent spread patterns showed very minimal variation from between independently metered and blended patterns.

SUMMARY

- P pattern differences were observed when the product being spread changed (need the ability to adjust in VRT situation)
- P-K segregation is prevalent during the spreading process, but not at fault of metering (need to rethink spreader settings)

FUTURE CONSIDERATIONS

If trying to achieve high levels of accuracy in a VRT independently metered system, spreader settings must be able to adjust as blends/sources change within a field.

PROJECT CONTACT

For inquiries about this project, contact Trey Colley, Graduate Research Assistant, Department of Food, Agricultural and Biological Engineering (Colley.65@osu.edu).

Observable differences in material properties between fertilizer sources. (DAP – Gray, Potash – Red)

Glossary

A

AB Line - An imaginary reference line set for each field that a tractor/sprayer guidance system to follow. There are different reference lines that can be set in a field to fit a particular geography or layout.

Agronomic Data - Represents data compiled from a specific farming operation or at the field level generally related to agronomy based information such as yield, population, hybrid, nutrient application. Agronomic Data is tied to the land or field where it was generated. Types of Agronomic Data include (but are not limited to) hybrid selections, plant populations, yield data, soils data, pesticide application details, and scouting information. Data generated from a yield monitor can be used to document yields, and for on-farm seed trials. In addition, yield monitor data can be used to make genetic, environmental, and management effect analyses. Soils data is being used to make fertilizer and regional environmental compliance decisions, while scouting data is being used to make spraying decisions as well as regional pest or disease analytics.

As-Applied Map - Is a map containing site-specific information about the location and rate of application for fertilizer or chemical input. Usually created with a GPS equipped applicator and data logger.

Automatic Section Control - Turns application equipment OFF in areas that have been previously covered, or ON and OFF at headland turns, point rows, terraces, and/or no-spray zones such as grass waterways. Sections of a boom or planter or individual nozzles/rows may be controlled.

Autonomous Operation - Vehicle guidance without the need for human intervention. A tractor may be driven by a series of on-boards sensors and GPS for precision driving without damage to crops.

Auto-Steer - A GPS guidance system that steers agricultural equipment with centimeter accuracy. This level of accuracy requires real time kinematic (RTK) correction of GPS signals. Auto-steer is an add-on component for equipment. It includes both the GPS system to receive and process the signals, software and hardware to allow the input of control maps and the mechanical equipment to actually steer the tractor. Some new tractors are available “auto-steer ready.”

Auto Swath - GPS machine control systems that include boom control and planter control by row sections or individual row.

B

Base Station - The RTK-GPS receiver and radio that are placed in a stationary position, functioning as the corrections source for roving tractor units in an area. These stations can be either portable or permanently installed systems and their coverage can range from 5 to 10 miles depending on topographic conditions, antenna height, and radio-transmit power. Also called a reference station, is a receiver located at a surveyed benchmark. The base station calculates the error for each satellite and through differential correction, improves the accuracy of GPS positions collected at unknown locations by a roving GPS receiver.

Baud Rate - Rate at which information is transferred in a communication channel. Refers to the number of signal or symbol changes that occur per second. Higher baud rates have more bits per second transferred.

C

CAN-Bus (in tractors and implements) - CAN-Bus is a high-speed, wired data network connection between electronic devices. The hardware/wiring of CAN-Bus networks are generally the same, while the protocols for communication can be different and vary depending on the industry where they are used. These networks are used to link multiple sensors to an electronic controller, which can be linked to relays or other devices on a single set of wires. This reduces the amount of wires needed for a system and allows for a cleaner way to connect additional devices as system demands change.

Compact Measurement Record (CMR) - Survey grade communication & differential corrections. There are three different forms (CMR, CMR+, and CMRx) and the difference between them is the amount of correction data that can be obtained due to the amount of satellites. It’s common to see this term using Trimble GPS systems.

Coordinate System - Used in GPS/GNSS navigational systems to reference locations on Earth. There are many coordinate systems but frequently used ones include: latitude and longitude, Universal Transverse Mercator (UTM), and State Plane coordinate systems.

Continuously Operating Reference Station (CORS) [Network] - A network managed by the U.S. office of National Ocean Service (NOAA) to provide GNSS data consisting of carrier phase measurements throughout the United States. CORS eliminates the need for producers to purchase a personal base station, thereby lowering investment costs for RTK applications, and initial research has indicated that CORS can provide RTK-level correction within a 20 mile radius of the station’s location. Because CORS data is transmitted over the internet there are no line of sight requirements as with radio transmitted signals.

Crop Sensors - Optical crop sensors used to measure and/or quantify crop health or evaluate crop conditions by shining light of specific wavelengths at crop leaves, and measuring the type and intensity of the light wavelengths reflected back to the sensors.

D

Differential Global Positioning System (DGPS) - A method of using GPS which attains the position accuracy needed for precision farming through differential correction.

Differential Correction - Correction of a GPS signal that is used to improve its accuracy (to less than 100 m/~330 ft) by using a stationary GPS receiver whose location is known. A second receiver computes the error in signal by comparing the true distance from the satellites to the GPS measured distance.

Digital Elevation Model (DEM) - A digital representation of a surface, used for topography.

Dilution Of Precision (DOP) - One of many quality measurements to evaluate solutions derived by a positioning receiver. This is a numeric value that relates relative geometries between positioning satellites as well as the geometries between the satellites and the receiver; the lower the value, the higher the probability of accuracy. DOP can be further classified to other variables: GDOP (three-dimensional position plus clock offset), HDOP (horizontal position), PDOP (three-dimensional position), TDOP (clock offset), and VDOP (vertical position). A DOP value of 4 or less is typically desired for best accuracy.

Directed Sampling - Simple technique of incorporating prior knowledge about soil variability into the sampling design to match sampling distribution and intensity with known soil patterns.

F

Fix - A single position calculated by a GPS receiver with latitude, longitude, altitude, time, and date.

G

Geographic coordinate system - A reference system using latitude and longitude to define the locations of points on the surface of a sphere or spheroid.

Geographic Information System (GIS) - A computer based system that is capable of collecting, managing and analyzing geographic spatial data. This capability includes storing and utilizing maps, displaying the results of data queries and conducting spatial analysis. GIS is usually composed of map-like spatial representations called layers which contain information on a number of attributes such as elevation, land ownership and use, crop yield and soil nutrient levels.

GLONASS (GLObal'naya NAvigatsionnaya Sputnikovaya Sistema) - The satellite-navigation network maintained by the Russian government. The English translation of this name is “GLObal NAvigation Satellite System,” or more commonly named “GLONASS.” Utilizing GLONASS enabled receivers for precision ag applications provides additional satellite coverage and often improved performance of guidance systems. See also GNSS. Russian version of the American GPS satellite system. It is a radio-based satellite navigation system operated for the Russian government by the Russian Space Forces with a constellation of 24 operational satellites in 2010.

Global Navigation Satellite System (GNSS) - Refers to using multiple satellite navigation systems concurrently by a GPS receiver to compute its position. What makes a GNSS receiver superior to a GPS receiver is its capabilities of receiving signals from navigational satellites other than, and in addition to, those that are of the GPS network. There are two operational satellite navigation systems at this time: The United States of America’s GPS and Russia’s GLONASS.

GNSS Receiver - A computer-radio device that receives satellite information by radio waves to determine the position of the antenna relative to earth’s surface.

GNSS Satellite - A communication vehicle that orbits the earth. Satellites send time-stamped signals to GPS or GNSS receivers to determine positions on earth.

Grid Soil Sampling - Laying a grid over a map of a field and taking soil samples at the middle of each grid on the map. May be done at much higher densities (up to 42 samples per acre) to approximate the true spatial variability of a number of soil nutrient levels.

Ground Sampling Distance (**GSD)** - Pixel size of remotely sensed imagery. Example: 30-meter; 1-meter; 20-centimeters.

Guidance - The determination of the desired path of travel (the "trajectory") from the vehicle's current location to a designated target, as well as desired changes in velocity, rotation and acceleration for following that path. There are two basic categories of guidance products: lightbar/visual guidance and auto-guidance. For lightbar/visual guidance, the operator responds to visual cues to steer the equipment based on positional information provided by a GPS. For auto-guidance, the driver makes the initial steering decisions and turns the equipment toward the following pass prior to engaging the auto-guidance mechanism. Auto-guidance can use differential correction such as WAAS, subscription services, and RTK. RTK is the most accurate level of auto-guidance available, typically +/- 1 inch. Benefits include improved field efficiency, reduced overlap of pesticide applications, time management and reduced driver fatigue. See also WAAS, Subscription Correction Signal and RTK.

I

Industrial Internet - A term coined by Frost & Sullivan and refers to the integration of complex physical machinery with networked sensors and software. The industrial Internet draws together fields such as machine learning, big data, the Internet of things, machine-to-machine communication and Cyber-physical system to ingest data from machines, analyze it (often in real-time), and use it to adjust operations. Some consider the evolution of digital agriculture today (e.g. 2015) as leading to the Industrial Internet in agriculture.

Internet of Things - The network of physical objects or "things" embedded with electronics, software, sensors, and network connectivity, which enables these objects to collect and exchange data. The Internet of Things (IoT) allows objects to be sensed and controlled remotely across existing network infrastructure, creating opportunities for more direct integration between the physical world and computer-based systems, and resulting in improved efficiency, accuracy and economic benefit. Each thing is uniquely identifiable through its embedded computing system but is able to interoperate within the existing Internet infrastructure. Experts estimate that the IoT will consist of almost 50 billion objects by 2020.

ISOBUS - ISOBUS standard 11783 is a communication protocol for the agricultural industry that is used to specify a serial data network for control and communications on forestry or agricultural tractors and implements. ISOBUS-compliant tractors and implements come with round 9-pin connectors.

L

LANDSAT (LAND SATellite) - A series of U.S. satellites used to study the earth’s surface using remote sensing techniques.

Lightbar - Is a navigation tool coupled with a GPS designed to keep the driver on-course. Applications include planting and fertilizer applications to reduce skips and overlaps. Typically, guidance is provided through a series of LED lights.

Latitude - A north/south measurement of position perpendicular to the earth's polar axis.

Longitude - An east/west measurement of position in relation to the Prime Meridian, an imaginary circle that passes through the north and south poles.

M

Machine Data - Data that is compiled using multiple sensors located on agricultural machinery. Most relate machine data to the information that can be collected from the CAN (controlled area network) on machines and implements. Machine data can also include guidance system information (autosteer, GPS path files, bearing, etc.), variable rate control/technology and seeding rate controllers. Data in these forms is transmitted to Agricultural Technical Providers (ATPs) via CANBus, which is a high-speed, wired data network connection between devices. This device utilizes a single wire set to relay information, which reduces the amount of wires needed for a system and allows for a cleaner way to transfer data.

Management Zone - Management zones are created by subdividing a field into 10-20 acre areas with similar characteristics. Yield maps, soil texture maps, elevation data, EC data, sensor data and farmer knowledge can be used to create management zones in GIS software. There are several methods available for creating management zones.

Mass Flow Sensor - Is a sensor that measures grain flow in a yield monitor system.

Moisture Sensor - Is a sensor that measures grain moisture in a yield monitor system.

N

National Marine Electronics Association (NMEA) - Set communications standards for GPS data.

Near Infrared (NIR) - Near infrared (red), green (blue), red (green) is useful in seeing changes in plant health.

Normalized Difference Vegetation Index (NDVI) - The ratio of the difference between the red and near-infrared bands divided by their sum used to identify and enhance the vegetation contribution in a digital remote sensing analysis; a simple graphical indicator that can be used to analyze remote sensing measurements and assess whether the target being observed contains live green vegetation or not.

NAVSTAR (NAVigation by Satellite Timing and Ranging) - The U.S. based global navigation satellite system that was funded by taxpayers and controlled by the DOD.

O

OmniSTAR - A subscription based differential GPS source. Omnistar is a satellite-based DGPS source that requires a special GPS antenna.

P

Precision Agriculture - Precision agriculture is a farming management concept based on observing, measuring and responding to variability in crops. These variabilities contain many components that can be difficult to compute and as a result technology has advanced to off-set these difficulties. Two types of technology can generally be found within precision agriculture: those which ensure accuracy, and those that are meant to enhance farming operations. By combining these two technologies, farmers are able to create a decision support system for an entire operation, thereby maximizing profits and minimizing excessive resource use. This may include managing crop production inputs (seed, fertilizer, lime, pesticides, etc.) on a site-specific basis to increase profits, reduce waste and maintain environmental quality.

Prescribed Application - The dispensing of a material or chemical into the field on a prescribed or predetermined basis. A prescription map is generated by an expert (grower and/or agronomist) based on information about the field in use before an application. The prescription determines how much of something will be applied.

Prescription Map - A prescription map tells the rate controller how much product to apply based on the location of the equipment in the field.

R

Rate Controller - An electronic device that varies the amount of chemical/plant nutrient applied to a given area.

Remote Sensing - The act of detection and/or identification of an object, series of objects, or landscape without having the sensor in direct contact with the object. The most common forms include color and color infrared aerial photography, satellite imaging and radar sensing.

Real-Time Correction - correction of a GPS signal by simultaneously transmitting the differential correction information to a mobile receiver.

Real-Time Kinematic (RTK) - Real-Time Kinematic is a high-end GPS capable of centimeter level positional accuracy. A procedure whereby carrier-phase corrections are transmitted in real time from a reference receiver to the user's receiver. Depending on local availability, RTK corrections can be delivered by radio modem from an on-site base station or a state's CORS network, or even over the internet using Wi-Fi.

S

Site Specific Crop Management (SSCM) - The use of yield maps, grid sampling and other precision tools to manage the variability of soil and crop parameters and aid decisions on production inputs (also referred to as Precision Farming)

Sensor Technologies - Sensor technology refers to on-the-go optical sensors used to measure crop status. These sensors utilize an active LED light source to measure NDVI (Normalized Difference Vegetative Index) to predict crop yield potential. NDVI values reflect the health or "greenness" of a crop and can also provide a relative biomass measurement. Data collected from these sensors are being used to direct variable rate nitrogen applications in grain crops and plant growth regulator and defoliants in cotton.

Shortwave Infrared (SIR) – Shortwave infrared (red), near infrared (green), and green (blue) used to show flooding or newly burned land.

SSURGO (Soil SURvey GeOgraphic) Database - A digital version of the NRCS soil books. Each soil type is represented as a polygon and tied with associated soil type properties.

T

Terrain Compensation - An add-on feature for auto-guidance systems which correct position error that may occur when equipment travels over rolling terrain. Roll, pitch and yaw are commonly referred to when discussing terrain compensation. Roll refers to the change in elevation between the left and right sides of the vehicle; pitch refers to the change in elevation between the front and rear of the vehicle; and yaw refers to any sliding or turning motion of the vehicle to the left of right.

Thermal Infrared (TIR) - Shown in gray tones to illustrate temperature. It measures radiation from the plant and soil surface.

U

Universal Transverse Mercator (UTM) - Coordinate system that represents the earth's spherical shape as 2 -D zones that are evenly spaced grid lines.

Unmanned Aerial Vehicle (UAV) - An unmanned aerial vehicle (UAV), commonly known as a drone and also referred by several other names, is an aircraft without a human pilot aboard. The flight of UAVs may be controlled either autonomously by onboard computers or by the remote control of a pilot on the ground or in another vehicle. In agriculture, UAVs are typically used to survey crops. The available two types of UAVs – fixed-wing and rotary-wing – are both equipped with cameras and are guided by GPS. They can travel along a fixed flight path or be controlled remotely.

V

Variable Rate Technology (VRT) - GPS and precise placement technology that uses an "application guidance" map to direct the application of a product to a specific, identifiable location within a field. Instrumentation such as a variable-rate controller for varying the rates of application of fertilizer, pesticides and seed as one travels across a field. VRT consists of the machines and systems for applying a desired rate of crop production materials at a specific time (and, by implication, a specific location); a system of sensors, controllers and agricultural machinery used to perform variable-rate applications of crop production inputs; refers to a system that varies the rate of agricultural inputs such as seed, fertilizer, and crop protection chemicals in response to changing local conditions.

Vegetation Index(VI) - A ratio created by dividing the red by the near-infrared spectral bands used to identify and enhance the vegetation contribution in a digital remote sensing analysis.

Variable Rate Application (VRA) - Adjustment of the amount of crop input such as seed, fertilizer, lime or pesticides to match conditions (yield potential) in a field.

Y

Yield Calibration - Procedures used to calibrate a yield monitor for specific harvest conditions such as grain type, grain flow, and grain moisture.

Yield Mapping - Is a yield monitor coupled with a GPS. Each yield reading is tagged with a latitude and longitude coordinates, which is then used to produce a yield map. Refers to the process of collecting geo-referenced data on crop yield and characteristics, such as moisture content, while the crop is being harvested.

Yield Monitor - A yield-measuring device installed on harvest machines. Yield monitors measure grain flow, grain moisture, and other parameters for real-time information relating to field productivity.

(Definitions from AgGlossary, PrecisionAg, University of Nebraska Lincoln, Alabama Cooperative Extension System, and Ohio State Precision Ag)

Tools of the Trade

AirScout Aerial Imagery

Manned aircraft in-season flights—*AirScout's web-interface and iPad based App allows for directive in-season scouting and crop vigor assessments.*

Bazooka Farmstar Manure Injection Toolbar

Manure injection toolbars, like this one from Bazooka Farmstar, allow for liquid manure injection at corn sidedress, capturing valuable ammonia N for the corn plant. Commercial manure application—efficient & effective.

Bombauer Manure Toolbar

Drag hose manure applicator—The Bombauer Manure Toolbar used in this study offers growers the opportunity to apply manure as a sidedress application.

Camso Track System

The Camso track systems for tractors offer the ability to increase the soil surface to track ratio, which in turn reduces soil compaction levels. In this study, the tracks were installed on a JD 8320 R tractor.

Case IH Magnum 380 CVT

The Case IH 380 CVT tractor uses a continuously variable transmission to provide smooth field and road operations. The Ohio State Precision Ag Team employs multiple Magnum Tractors in their fleet

Case IH Wing Downforce Control System

Hydraulic Downforce Control -*The Case IH Wing Downforce Control System allows for on the go wing downforce control. This system provides optimal conditions for row units.*

DJI Phantom 4

Quad-Copter—The DJI Phantom 4 was used to assist in scouting throughout the year. The Nitrogen trials were flown during the growing season to reveal treatment differences.

eBee Drone

Drones provide farmers the opportunity to visualize entire fields from an aerial perspective. Drone collected images help detect area of concerns, and execute farming operations more effectively and efficiently, including crop scouting, and crop and soil health monitoring.

FieldView™ Drive

Data Collection Device—The Drive collects operational data through the CAN port. This enables the producer to record data such as machine analytics, yield data, planting data, application data, and many other forms of ag data.

FieldScout SC-900

The SC-900 Compaction Meter provides an easy way to identify the depth of the compacted layer in agricultural fields. In this study, the SC-900 was used to determine the shank depth of the strip-till. Shanks were then set at the proper depth to shatter the compacted layer

High Speed, Low Disturbance (HSLD)

Several agricultural equipment manufacturers now offer a high speed, low disturbance system for placing nutrients below the surface. John Deere's 2510H is one such toolbar that allows for dry, liquid or gas nutrient placement in an efficient and environmentally friendly way.

John Deere Individual Row Hydraulic Downforce

IRHD works as a closed-loop downforce system that reacts on an individual row basis to changing soil conditions, supporting increased ground contact, which can lead to improved seed depth consistency.

New Holland N Coulter Bar

Late Season N Placement—This 36 ft late season N coulter bar enables producers to put Nitrogen below the surface of the soil even at late growth stages. In this study, we used the bar to apply 28% UAN at the V10 growth stage.

New Holland SP 300 F

High Clearance Sprayer—*The New Holland SP 300 F Sprayer offers the opportunity to apply late-season N by boasting a high clearance platform. The front boom allows for greater visualization of the applicators during operation.*

NutraBoss

Nitrogen Application Equipment—The NutraBoss Applicator can be used to execute late season nitrogen applications.

Ohio State Plots App

On-farm Research App—The Ohio State Plots App enables growers to layout in-field research trials, calculate statistics, and share results.

Orthman 1tRipr Row Unit

Adjustable heavy duty shank allows for ideal seedbed preparation. Can be equipped with dry, liquid, or anhydrous fertilizer attachments. Can place multiple products at varying depths

Parrot Sequoia Multispectral Camera

The Sequoia multispectral sensor captures both visible and invisible images, providing calibrated data to optimally monitor the health and vigor of your crops. Sequoia captures calibrated wavelength, Green, Red, Red-Edge and Near Infrared to highlight the health of plants.

Precision Planting 20/20

The 20/20 SeedSense Planting Monitor, when paired with a Precision Planting Downforce control system, allows the producer adjust downforce levels on a row-by-row basis. In this study, the monitor was used to set the for each treatment.

Precision Planting DeltaForce

DeltaForce allows helps the row unit place seeds at precisely the right depth by maintaining an accurate load on the row unit. Pairing DeltaForce with the 20/20 display allows the operator to adjust row unit downforce levels in real-time

Precision Planting SpeedTube

Electric row by row seed delivery—SpeedTube allows the row unit place seeds at precisely the right spacing by matching planting speed with near 0 velocity seed drop. Pairing SpeedTube with the 20/20 display and vSet electric drive allows the operator to observe and adjust row unit parameters in real-time to preserve yield.

Precision Planting YieldSense

Precision Yield Monitor—*The precision planting YieldSense yield monitor allowed for accurate measurement of strip treatment yields during the harvest season*

SEEK Thermal Camera

The SEEK Thermal Camera uses a thermal sensor to detect changes in heat surrounding an object. We used it to observe stress levels in "Terra-byte", but luckily found none. This camera is compatible with iPhone or Android.

Soucy S-TECH 012P

The Soucy S-Tech Planter Track system provides the opportunity to reduce the amount of soil compaction while planting. These tracks increase the soil-track contact surface, distributing the planter weight more evenly.

Standard Collection Pan

Pan testing not only evaluates the degree of uniformity across the swath, but also determines the type of spread pattern, the effective swath width, and the rate of application. It is important to follow the ASABE and ISO Standards when testing for spread uniformity.

vSet Select Seed Meter

The vSet Select Meter from Precision Planting allows for precise placement of two hybrids with outstanding accuracy. In this study, the meter was used to plant two hybrids at a variable rate based on our seeding prescription.

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COLLEGE OF FOOD, AGRICULTURAL, AND ENVIRONMENTAL SCIENCES

COLLEGE OF ENGINEERING

Contact us:

Digital Ag Program

590 Woody Hayes Drive
Columbus, OH 43210
DigitalAg@osu.edu