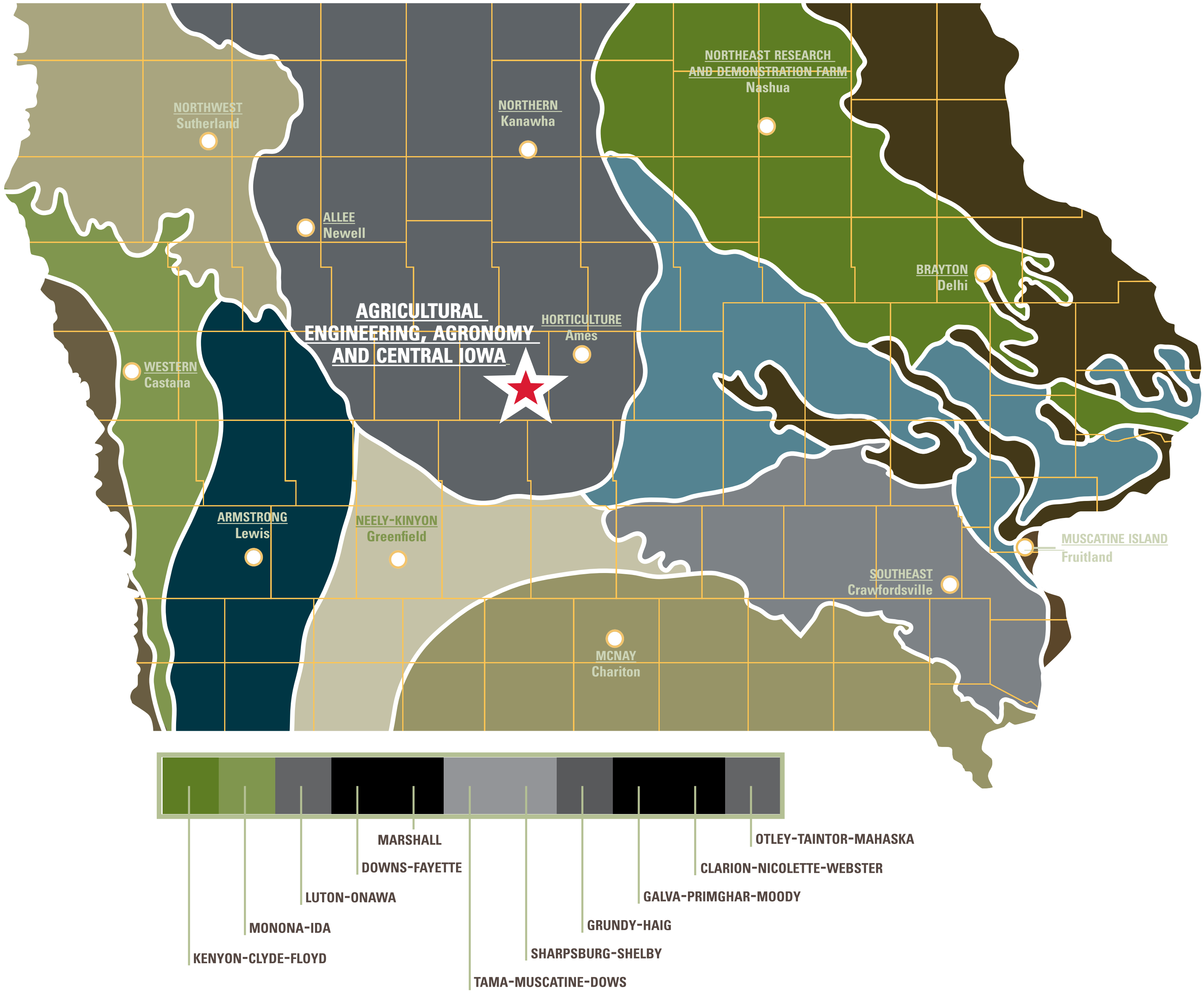
Iowa State University
College of Agriculture and Life Sciences

Research and Demonstration Farms

Agricultural Engineering/Agronomy Farm and Central Iowa Research Farms

2022 SUMMARY



ISRF22c April 2023

Research and Demonstration Farms

In 1858, the Iowa Legislature chartered the Iowa Agricultural College and Model Farm. Today, the College of Agriculture and Life Sciences at Iowa State University is one of the world's leading institutions of agriculture, providing leadership in science, education, and extension.

Iowa State University has a long heritage of teaching, research, and extension programs focused on agriculture. The campus itself was originally a model farm. Now the College of Agriculture and Life Sciences and the agricultural affiliates are served by a network of farms in Story and Boone counties near Ames.

The current Agronomy and Ag Engineering Research Farms were established west of Ames in the early 1960s.

In 2009, the BioCentury Research Farm opened as the first-in-the-nation integrated research and demonstration facility dedicated to biomass production and processing. The facility was built adjacent to the Ag Engineering/Agronomy Research Farm to study production, harvesting and conversion of biomass to fuels, chemicals and products.

IOWA STATE UNIVERSITY
Extension and Outreach

College of Agriculture and Life Sciences
Agriculture and Home Economics Experiment Station
Iowa State University Extension and Outreach

Agricultural Engineering/Agronomy Farm

Mike Fiscus—superintendent

Nathan Meyers—manager

Jeff Erb— farm equipment mechani

Andrew Fisher—agricultural specialist

Zachary Koopman—agricultural specialist

Tim Ritland—agricultural specialist

Nick Upah—agricultural specialist

Central Iowa Farms, ISU Curtiss Farm

Kent Berns—superintendent

Karl Nicolaus—agricultural specialist

John Reinhart—farm equipment operator

Committee for Agricultural Development

Kevin Scholbrock—superintendent

Karl Nicolaus—agricultural specialist

Compost Facility

Steve Jonas—agricultural specialist

Arlie Penner—agricultural specialist

BioCentury Research Farm

Andrew Suby—manager

Agricultural Engineering/Agronomy Farm and Central Iowa Research Farms

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IOWA STATE UNIVERSITY
Ag Engineering / Agronomy
Research Farm
Est. 1964

Agricultural Engineering and Agronomy Farm Summary

Mike Fiscus—farm superintendent, Agricultural Engineering and Agronomy

Nathan Meyers—agricultural specialist, Agricultural Engineering and Agronomy

Farm Comments

Field days and tours. The farm hosted 450 visitors during the year. The Ag Engineering and Agronomy Research Farm (AEA) hosted the National Association of Plant Breeders in August as part of their annual convention held in Ames. Plant breeders attending the convention were invited to the farm to view demonstration plots exhibited by the corn, soybean, and sorghum breeding groups. The demonstration plots exhibited current and historical work accomplished at Iowa State University and was well received by all attendees. Other field days included an ag leadership tour group from northwest Iowa, and smaller field day events in association with the forage and sustainable ag research groups at Iowa State.

Developments. Research efforts at the farm were at field capacity with many continuing long-term projects and research activities related to breeding programs, weed, disease, insect, and crop fertility. Water quality studies continue to be one of the focus areas of research. There are five water quality studies evaluating water quality entering tile lines in the agricultural landscape of Iowa. Tile lines running underneath replicated plots, are routed to underground sump basins, where water samples are taken on a regular basis. Nitrate, nutrient leaching, basic waterflow according to crop rotation, and other factors related to crop production are monitored.

Two saturated buffers are being evaluated at the Boyd and Burkey farms, monitoring water flow and nitrate retention in the buffers.

Facilities and equipment. A broadband tower was installed north of the main headquarters building. The tower will be used to transmit broadband signals across Iowa State farms in Story and Boone County. The project is led by Hongwei Zhang of the electrical and computer engineering department. The signal generated by the towers will be utilized by research groups working in field plots to facilitate transmission of data back to campus and provide connectivity to digital ag components in agricultural field equipment.

Crop Season Comments

Oat seeding was started and completed April 11. Oats were harvested in mid-July, with an average yield of 65 to 150 bushels/acre, depending on fertility protocols of the harvested fields.

Corn planting started May 19 and was completed June 14. Planting was delayed due to saturated soil moisture levels from October rainfall in 2021 and spring rainfall events in April and May. Harvest began October 14 and was completed by November 11. Average yields were in the 200 bushel/acre range. Rainfall events throughout the summer contributed to respectable yields across the farm.

Soybean planting began June 1 and was completed June 20. Timely planting was delayed by spring rains in May and June. Harvest began October 11 and was completed by October 20. The whole-farm average was 45 bushels/acre.

Weather Comments

Winter. Total snowfall for January, February, and March was 16.7 in., with rainfall equivalent and rainfall total of 4.34 in.

Spring. A rainfall total of 17.49 in. was recorded for the months of April, May, and June (Table 1), with 8.98 in. of that total in June. The three-month total was 5.04 in. above average. The high rainfall rates led to a saturated soil profile, which contributed to late planting conditions in the Ames area. The last killing frost was April 19, with a low temperature of 23º F. June was warm, averaging 4.77º F above normal. There were nine days of 90ºF or above in June.

Summer. A total of 10.16 in. of rain fell during the summer months of July through September. July recorded 10 days with temperatures 90°F or above.

Fall. A total of 3.37 in. of rain was recorded for the months of October through December. The first killing frost of 25 degrees was October 15. October was dry with only 0.52 in. of rainfall, which led to good harvest conditions. A total of 3.3 in. of snow fell in mid-November and 9.3 in. of snow fell during the last half of December.

A total of 35.36 in. of rain was recorded for 2022, 3.09 in. above normal.

Acknowledgements

The following companies and individuals contributed to research activities at the Iowa State Ag Engineering/Agronomy Research Farm. Their support is greatly appreciated: AGCO Corporation, AMVAC Chemical, Bayer CropScience, Calcium Products, Case-IH, Corteva/Pioneer Seed, Gandy Corporation, John Deere, Nutrien Ag Solutions, Soil Warrior Company.

Table 1. Monthly rainfall and average temperatures–2022 growing season.

Month	Rainfall, inches	Deviation from normal	Temperature °F	Deviation from normal	Days 90° or above
March	3.52	1.70	40	3.98	0
April	4.45	1.25	46	-3.67	0
May	4.06	-0.38	64	3.11	5
June	8.98	4.17	75	4.77	9
July	3.20	0.47	76	1.63	10
August	5.08	1.10	74	1.95	5
September	1.88	-1.72	67	2.56	2
October	0.52	-1.94	53	0.46	0
Total	31.69	3.71			31

Table 2. 11-year summary of monthly precipitation.

Month	NR1	ANR2	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
January	0.79	0.79	1.17	0.70	0.26	0.41	0.10	0.19	0.60	1.85	1.31	0.54	0.76
February	0.94	1.73	0.75	1.06	1.74	0.73	1.15	0.94	0.68	1.20	1.16	1.70	.050
March	1.79	3.52	2.07	0.79	2.49	1.48	1.00	0.21	1.48	3.11	2.49	1.50	2.65
April	3.23	6.75	3.66	4.41	4.79	5.81	4.75	3.45	4.09	3.06	1.27	1.94	1.49
May	4.41	11.16	3.64	4.62	2.46	7.09	4.26	4.57	4.28	6.16	3.98	8.32	5.28
June	4.83	15.99	11.17	5.05	2.94	3.01	8.86	6.90	0.97	1.73	11.10	3.97	1.57
July	3.68	19.67	6.74	3.90	1.47	1.01	2.88	5.96	5.85	0.99	4.21	4.61	2.79
August	4.02	23.69	11.21	3.58	2.98	2.18	5.70	8.26	8.23	3.34	8.41	1.30	1.02
September	3.62	27.31	6.57	2.02	1.85	1.19	5.55	5.05	7.90	1.80	6.75	4.56	3.19
October	2.43	29.74	0.38	0.86	2.34	2.50	3.75	1.27	0.59	6.07	4.85	5.24	1.07
November	1.53	31.27	2.23	2.72	0.90	1.40	0.71	2.75	1.74	0.26	1.62	1.33	1.95
December	1.05	32.32	0.80	2.23	1.02	0.32	1.15	5.05	1.17	0.17	2.62	1.08	0.79
Total	32.32		50.39	31.94	25.24	27.13	39.86	44.60	37.58	29.74	49.77	36.09	22.61
Departure from normal			18.07	-0.38	-7.08	-5.19	7.54	12.28	5.26	-2.58	17.45	3.71	-9.27

Research Projects

Project	Project Lead
Corn earworm evaluation trial	C. Abel
High fidelity genetics root tracker trial	S. Archontoulis
Long-term nitrogen corn trial	
Forecast and assessment of cropping systems (FACTS)	
Crop residue/nitrogen retention trial	
Miscanthus research	N. Boersma
Miscanthus/corn nitrogen rate trial	
Switchgrass variety trial	
DrainSpace tile depth study	M. Castellano
Pivot Bio corn trials	
INRC corn and soybean trial	
Iowa nitrogen initiative	
John Deere planter evaluation trials	M. Darr
John Deere spraying systems trial	
Humic acid corn and soybean trials	D. Dinnes
Organic corn breeding trial	J. Edwards
Corn breeding nursery	
Corn hybrid nitrogen efficiency trial	J. Edwards/S. Archontoulis
Corn rootworm research	A. Gassmann
Soybean genetic mapping	J. Hayes
Prairie forbs establishment trials	R. Hellmich
Soil cube /biological nitrogen project	M. Helmers
Saturated buffer observation trials	T. Isenhart
Weed science cover crop trial	P. Jha
Weed science pesticide evaluation trials	
Weed seed destructor trial	
DOP soybean relative maturity trial	Z. Koopman/M. Witt
Soybean planting population study	
Foliar biological treatment on soybean	
Foliar AMS on soybean	
Comparison of biofuel systems (COBS)	M. Liebman
Sustainable ag cropping systems	
Long-term tillage study	M. Licht
Microbial nitrogen fixation corn trial	
Soybean foliar biological trial	
Soybean biological seed treatment trial	
Stand reduction/greensnap corn trial	
Biological coated urea corn trial	

Project	Project Lead
Corn breeding/double haploid research	T. Lubberstedt
Forage and biomass crop production	K. Moore
Envirotion facility	
FEEL research plots	D. Mueller
Plant Pathology corn-soybean tillage trial	
Plant Pathology foliar corn trial	
Plant Pathology soybean disease trials	
Corn seedling disease research	G. Munkvold
Organic cropping systems trial	P. O'Brien
LEBRC lab facility	B. Ramirez
Corn and soybean fungicide trials	A. Robertson
Corn cover crop disease trial	
Plant Pathology foliar corn trial	
LEBRC lab facility	B. Ramirez
Corn and soybean yield trials	J. Rouse/Ryan Budnik
Sorghum breeding	M. Salas
Mung bean research	A. Singh
Soybean breeding	D. Singh
Oat variety trial	M. Schnable
Corn breeding nursery	
Winter Rye Variety trial	
Corn nitrogen rate evaluation trial	
Corn breeding nursery	P. Scott
Bioreactor Evaluation Trial	M. Soupir
LAiYERS Water Quality Trial M. Soupir	
Oxbow and Bioreactor Site-Uthe Farm	
BCRF Plant Zoo	A. Suby
Robotic plant imaging study	L. Tang
Soil compaction tire trial	M. Tekesti
Self-propelled sprayer tire footprint trial	
Soil machine dynamics laboratory	
Soybean cyst nematode trials	Tylka/Gebhart
Enviratron facility	S. Whitham
Corn breeding trial	M. D. Yandeau-Nelson
Corn breeding/sorghum breeding	J. Yu
Broadband tower project	H. Zhang

BioCentury Research Farm Summary

Andrew Suby—assistant director, BioCentury Research Farm

The BioCentury Research Farm (BCRF) supported a diverse group of users and projects in 2022. Iowa State University faculty and staff from the Colleges of Engineering (COE) and Agriculture and Life Sciences (CALS) continued to conduct research, teach, and perform outreach at the BCRF. Private industry users included Deere and Company, Frontline Bioenergy, Gross-Wen Technologies (GWT), Hy-Vee Inc., Kemin, Roeslein, and others. The BCRF had more than 83 full- and part-time users with projects, and 34 student workers to support operations and research.

Research, Education, and Equipment

Project activity occurred in these areas: algae research and production methods, biochemical research, biomass feedstock logistics research, biomass preparation, biopolymer research, chassis dynamometer lab, digital agriculture, polymer and food protection program, thermochemical research, educational support/capstone facility, and equipment improvements.

Algae. Research work continued at the BCRF to support advancements in using algae to remove nitrogen and phosphorus from wastewater. Additional projects that were funded through US DOE BETO grant program focused on cultivating rapidly growing algae strains for use as a biofuel and bioplastic feedstock. The BCRF also housed the algae biofertilizer processing facility for GWT. The fertilizer produced at the BCRF facility was used to fertilize parks, lawns, and golf courses throughout Iowa.

Biochemical. The Center for Crop Utilization Research (CCUR) continued to work at the BCRF with industry partners at a high level of fermentation research project activity. Non-fermentation projects, such as milling, falling film evaporation, and drying wet cake to produce distiller's dried grains (DDG) using the BCRF's pilot-scale steam tube dryer, were continued. In all, 24 different companies received services during 2022.

Biomass feedstock logistics. A multiyear stover storage project was extended with the Idaho National Laboratory (INL). Various biomass feedstocks were prepared for industrial use.

Biomass preparation. The BCRF continued to prepare biomass feedstocks for several internal and external clients. The farm's biomass preparation lab was used to fine-grind, screen, size, and pelletize the feedstocks. Various hammermills were used to provide biomass material for multiple clients and to prepare samples for the Agronomy Department, the Iowa State Kent Feed Mill and Grain Science Complex, and others.

Biopolymer research. The Biopolymer Processing Facility produced enough asphalt binder material in 2021 to continue to supply demonstration projects in 2022. Commercialization of related materials and products continued for other applications, some of which were demonstrated at the 2022 Farm Progress Show in Boone, Iowa. The products are soy-based, replacing the petroleum-based binding agents used commercially as components in asphalt binder as well as a variety of maintenance products for asphalt shingles, asphalt pavement, and concrete. The research work is spearheaded by Eric Cochran, professor (CBE), and the biopolymer team and is sponsored by the United Soybean Board and others.

Chassis Dynamometer Lab. Upon completion of the construction phase, commissioning continued in earnest during the second and third quarter. The dedication ceremony was held on November 17 with participation of key contributors from Danfoss, Iowa State and others. The inaugural private industry project commenced in the fourth quarter.

Digital agriculture. The digital ag group continued growing their partnership with industry sponsors to a new record high since the inception of the BioCentury Research Farm. Reorganization of the facilities and equipment occurred to support the increased volume of ongoing projects, while maintaining security. In partnership with ISU Extension and Outreach, the group has shared equipment, technology, and agronomic expertise with farmers around Iowa to aid them in making sound decisions for their farming operations.

Polymer and Food Protection Program (PFPP). Keith Vorst's group moved into the east bay of the equipment building and began work on various research projects after the installation of necessary equipment. This work included characterizing landfill plastic material and creating compostable plastics by using biomass feedstocks and various other projects.

Thermochemical. The culmination of a three-year collaboration, the Bioeconomy Institute (BEI) continued its research partnership with Renewable Energy Group (REG) based in Ames, Iowa, via operation of a pilot scale multi-reactor hydrotreater. The pilot plant is designed to support REG's Geismar, Louisiana, renewable diesel plant and has been used to evaluate feedstocks and process variables that mimic the commercial facility. The fully automated system is designed to safely operate for weeks-long campaigns with minimal operator input.

Additionally, the BEI has completed the first round of collaborative testing with an internationally based startup company using their 1kg./hr. solvent liquefaction pilot plant. Promising results prompted the project to continue through 2023, which will expand testing and fund plant upgrades to better reflect next scale plant design.

Educational support/Capstone. The BCRF hosted or gave class support to 220 Iowa State Agricultural and Biosystems Engineering (ABE) and other students, which included seven classes and two capstone projects.

Facility and equipment improvements. Completion of work started in late 2021 included the new electrical panels installed to support PFPP equipment in the equipment building.

Outreach, Visitors, Events, Tours

Information dissemination and promotion mainly are accomplished through tours, conferences, and symposiums. The BCRF had 75 groups totaling 1,130 visitors in 2022. Since the dedication in 2009, BCRF has hosted 1,059 tours totaling 18,006 visitors.

The 2022 tours included visits by potential students, industrial clients, the Chinese Ambassador to the United States, and governmental officials.

Central Iowa Research and Demonstration Farms Summary

Kent Berns—farms superintendent, Central Iowa Farms

Farm Comments

The Iowa State University Central Iowa Farms (CIF) consist of farmland in Story and Boone counties. There were 2,326 crop acres under CIF management in 2021, with 415 acres devoted to intensive plot research. The additional acres were used for large-scale research, equipment testing, silage production, and manure application. The student-managed Ag 450 Farm rented approximately 185 acres through CIF. The Ag 450 Farm also was hired to perform custom farm work on a portion of the Central Iowa Farms. Central Iowa Farms purchased a larger tractor, larger field cultivator, and larger grain cart to assist bulk farming operations.

New projects. Tile repairs and improvements were conducted on the Accola and Dairy Farms. Construction continues on the Kent Feed Grain Mill.

Cereal rye was broadcast spread on no-till acres after harvest. Oats were used as a cover crop on acres harvested for corn silage. The irrigator at the Iowa State Curtiss Farm was operated two times during the season. The east field at the Bilsland Memorial Farm was used for sprayer development. Numerous fields were used for planter testing.

Crop Season Comments

The 2022 planting season was abnormal. Corn planting began May 10 in wet soils. Bulk soybean was planted late May/early June. The summer was extremely dry during July, August, and September. The crop progressed at a pace slightly ahead of normal. Corn fields showed low to moderate levels of tar spot.

Brown midrib corn was planted on the dairy to be used for silage. Corn silage yields averaged 21 tons/acre at 65% moisture with a 12 in. cut height. A total of 445 corn acres were harvested for silage. Those acres were tilled and seeded to a cover crop; however, germination was poor due to dry conditions. Bulk corn grain yields averaged 194 bushels/acre and harvest was completed mid-November.

Fall harvesting of corn began October 18 at 18% moisture. Corn harvest was completed in mid-November. Soybean harvest began October 3 and was completed in mid/late October.

Weather Comments

The Agricultural Engineering and Agronomy Farm weather summary represents the weather data for all of the farms in central Iowa covered by this report.

Iowa State Compost Facility

Steve Jonas—compost facility manager

The Iowa State University Compost Facility has completed 15 full years of operation. The facility is managed by the Iowa State Research Farms and has a separate revolving account that receives fees and sales and pays expenses. The facility is designed to be self-supporting,meaning it does not receive allocations for its operations.

Facility Summary

The compost facility consists of seven, 80 × 140 ft. hoop barns and a 55 × 120 ft. hoop barn, all with paved floors. This year a 75 × 89 ft. mono-slope steel frame building was constructed to store finished and screened compost, topsoil, and amended soil for sale. The facility also has a Mettler-Toledo electronic scale with a 10 ft. × 70 ft. platform to weigh all materials.

Key machinery at the compost facility includes: 1) compost turner, a pull-type Aeromaster PT-170, 14 ft. wide, made by Midwest Biosystems 2) a 2017 dump trailer made by Berkelman Welding, used to construct windrows and haul material; 3) a 2019 telehandler, Caterpillar TH408, with a bale spear, pallet forks, 1.25 yard bucket, and 2.75 cubic yard bucket; 4) a tractor, 2019 John Deere 6155R (150 PTO hp), with IVT (infinitely variable transmission) and front-wheel assist used to pull the turner and dump trailer; and 5) a wheel loader, 2013 John Deere 624K high lift. The wheel loader is the main loader used and the telehandler provides backup and operates in areas inaccessible to the wheel loader.

The compost blend targets are a carbon-nitrogen ratio of 25 to 30:1 and moisture of 45-50%. Porosity and structure affect how well oxygen flows into the pile and its availability to the microbes.

After a windrow is made with the dump trailer, the windrow is turned to mix all materials thoroughly. Within three to four days, the windrow heats to 140-160°F. Later, it is turned one to two times/week. The composting process takes about 12 to 16 weeks with 25 to 30 turns. Frequency of turning is determined by windrow temperature, moisture content, and weather. Turning provides mixing and aeration. When the oxygen level in the windrow falls below atmospheric oxygen levels, the windrows benefit from turning. The porosity of the windrows is related to moisture content and structure from particles like cornstalks.

2022 Updates

The facility receives manure and biomass from several Iowa State facilities: dairy farm, animal science teaching farms (including the equine barns), poultry farm, campus services (yard and greenhouse waste), ISU dining (food waste), Hansen Learning Center (arena wood shavings), BioCentury Research Farm, Ag Engineering/Agronomy Farm, plant introduction station, Reiman Gardens, horticulture station, and others. A total of 6,896 tons were received in 2022 (Table 1). This is about 8% less than 2021. Some of the decrease is attributed to drier weather and changes to dairy cattle management. About 77% of the incoming material came from the Iowa State Dairy Farm.

Table 1. ISU compost facility inputs.

Source	2022		2021	2020	2019	2018
	tons	% of total	tons			
Dairy manure[1]	2,547	34.8	4,001	3,975	4,497	4,729
Dairy solids[2]	0	0	41	450	609	688
Dairy pack[3]	2,823	38.6	1,699	1,676	2,190	1,709
Dairy subtotal	5,370	73.4	5,741	6,101	7,296	7,126
Campus[4]	400	5.5	337	441	416	421
An Sci manure	750	10.3	737	729	640	476
Dining[5]	222	3	191	198	295	355
Biomass[6]	223	3	86	14	0	6
Stalks[7]	201	2.7	260	372	427	275
Other[8]	153	2.1	79	203	201	201
Total	7319	100.0	7,431	8,058	9,275	8,860

[1]Semi-solid dairy barn scrapings. [2]Solids from the manure separator. [3]Bedded packs from dairy barns. [4]Consists of campus yard waste (leaves, etc.) and greenhouse waste.[5]Compostable dining hall and kitchen food wastes. [6]Biomass research wastes, usually corn stalks, switchgrass, corncobs, or similar waste feedstocks. [7]Cornstalks as a carbon source. [8]All other sources.

Table 2. ISU compost facility outputs.

Source	2022		2021	2020	2019	2018
	tons	% of total	tons			
Amended soil	4,058	94	2,893	3,289	4,442	4,999
Compost*	55	1	1,180	1,225	55	222
Stalks	201	5	0	30	0	0
Black dirt	0	0	0	0	0	92
Total	4,314	100	4,073	4,514	4,497	5,313

The facility generated compost and amended soil primarily for campus use. A total of 4,113 tons were outgoing from the facility in 2022, an increase of 1,220 tons (42%) compared with 2021 (Table 2). This was due to an increase in the needs from construction projects on campus. The inventory of finished compost remained about the same. Some compost was field-applied in the fall of 2021, which helped reduce inventory. About 2,084 tons of finished and screened compost were outgoing from the facility. The primary outgoing product was amended soil. Amended soil is a blend of compost and topsoil. Fifty-five tons of compost were used for several research projects as a soil amendment to plots.

The remaining cover on one of the large hoops that hadn't been replaced was replaced this fall. The hoop covers that cover the entire hoop structure from concrete wall to concrete wall, work well, and appear to be fairly durable. One more half cover on a smaller hoop will need to be replaced. Also in the fall, hoop structure damage from the derechos of 2020 and 2021 was fixed. There were several rafter pieces and legs that needed to be replaced. All of the older remaining hoops had the legs reinforced where these attach to the piers holding them up. A 1/4 inch plate of steel measuring 12 × 24 in. was used to attach the foot of the hoop legs more securely with the goal of minimalizing further damage.

One concrete apron was added to the west end of the smaller hoop barn last year. More aprons will be added in the coming years.

The material handling building was completed in spring 2020. It has been an excellent addition. The material handling building stores finished and screened compost, topsoil, and amended soil. With more material coming into the facility to compost, more space was needed for windrows. Thus, the new building allowed a hoop barn previously used for storage of amended soil to be used for composting.

Variable weather made composting at the facility challenging, although the dry year was generally beneficial. The early winter was warmer than average. January and February had average to below average temperatures with little snowfall until late winter/early spring, similar to 2021. The spring was cooler and wetter, which slowed the composting process. Overall, composting during the year went well. It was possible to screen all finished compost in the fall, similar to the previous year. The remainder of the fall was good for composting, therefore the windrows were drier going into winter.

The facility continued screening all compost needed for amended soil. A trommel screen is rented one to two times per year. The screen removes the foreign material and rocks. However, the screen does not break up soil chunks or separate wetter material well. The material that does not go through the screen is called overs. This material is put into windrows on an open air dirt pad to be reclaimed. This material is mostly rock, garbage, and compost that was too chunky to fit through the screen. These windrows of material are turned periodically to aid in drying. The warm and dry conditions of this last summer helped dry out the overs windrows so these would be easy to screen. Therefore, by drying this material in a windrow and re-screening, 80% can be recovered as clean.

During 2022, the central hoop barn was used for receiving, mixing, and storage of raw materials, and the remaining six hoop barns, plus the smaller hoop barn, were dedicated to general composting.

A project to compost the paper towel waste from the bathrooms around the vet med facility continued this year. This is being done to reduce the amount of garbage sent to the landfill.

The Iowa State Compost Facility continues to serve a unique and vital role in assisting ISU to be "greener" and more sustainable. The staff continues to improve the management of the compost to benefit the university.

Acknowledgements

The authors gratefully acknowledge the support and interest of the Iowa DNR, ISU College of Agriculture and Life Sciences, Iowa State Extension, Leopold Center for Sustainable Agriculture, and Iowa State Research Farms.

The authors also sincerely acknowledge the major Iowa State contributors and users: Animal Science Farms, BioCentury Research Farm, Ag Engineering/Agronomy Research Farm, Dairy Farm, Poultry Farm, Reiman Gardens, Design and Construction Services, Iowa State Dining, Athletic Department, Horticulture Station, and Campus Services.

Evaluation of Experimental and Registered Soil-Applied Insecticides for Management of Larval Corn Rootworm

Aaron Gassmann—professor, Department of Plant Pathology, Entomology, and Microbiology

Ben Brenizer—research scientist, Department of Plant Pathology, Entomology, and Microbiology

The purpose of this study was to evaluate the effectiveness of soil-applied insecticides for management of corn rootworm (CRW) larvae. The insecticides evaluated in this study were: Ampex SC(2055), Capture LFR, and Force Evo. The corn used for this study was a hybrid that contained no Bt traits for CRW. Although Ampex currently is not registered by the Environmental Protection Agency (EPA), and is an experimental product, it may become available for management of larval rootworm in the future. Both Capture LFR and Force Evo are registered by the EPA and available for management of corn rootworm larvae.

Materials and Methods

Study location. The study was conducted at the Iowa State University Bruner Farm. The field site had been planted the previous year with a trap crop, which is a mixed-maturity blend with a greater proportion of late-maturing varieties. This trap crop constitutes a favorable environment for adult female rootworm late in the season when other fields are maturing, and typically results in a high abundance of rootworm larvae the following year.

Field plot design. This study was a randomized complete block design with four replications. Treatments were four rows wide, and 35 ft. long. Plots were trimmed to 30 ft. in length after planting.

Planting. This study was planted June 1, using a four-row John Deere Max EmergeTM 7100 Integral Rigid Frame Planter with 30-in. row spacing. The study planted at a depth of 2 in., with a spacing of approximately 6 in. between seeds (35,600 seeds per acre).

Liquid soil-applied insecticides. Insecticides were applied in-furrow at planting with a compressed-air system built directly into the planter by Almaco manufacturing. All liquid products were applied as ounces per 1,000 row feet. All liquid insecticides were applied with a Teejet XR80015EVS spray nozzle at 21 psi. to deliver 5 gpa. of finished spray at a tractor speed of 4 mph. Before the field season, new spray nozzles were installed and calibrated with water to ensure proper application of product. For these liquid applications, each row was checked for correct spray pattern prior to plot application and monitored during application to ensure insecticides were applied correctly.

Stand counts. On June 14, the first set of stand counts were recorded in all treatments. These were measured by using a 2 in. PVC pipe cut to the length of 17.4 ft. (1/1,000 of an acre for 30 in. row spacing) that was placed between two rows of corn, and the number of plants in both rows then counted. On June 21, a second set of stand counts were measured in all treatments. Late season stand counts were measured October 14, following the same procedure as the earlier stand counts. Measurements for all dates were averaged to provide a single value for stand counts (Table 1).

Table 1. 2022 Average Stand Count. Bruner Farm, Boone county.[1]

Treatment[2]	Formulation	Rate[3]	Placement[4]	Stand Counts[5,6]
Ampex SC(2055)[7]	1.71 SC	0.68	Furrow	34.5
Force Evo	2.10 EC	0.57	Furrow	34.1
Ampex SC(2055)[7]	1.71 SC	0.46	Furrow	33.7
Capture LFR	1.50 SC	0.98	Furrow	33.2
Untreated check				33.1

[1]Planted June 1; evaluated June 6, June 21, and October 14.
[2]Non-CRW Bt = An absence of any Bt trait targeting corn rootworm.
[3]All insecticides listed as fluid ounces per 1,000 row feet.
[4]Furrow = All insecticides were applied as liquids in furrow at planting time.
[5]Data presented as plants per 1/1000 of an acre.
[6]No significant differences between means (ANOVA, $P \geq 0.05$).
[7]Ampex currently is not registered by the EPA and is an experimental insecticide.

Root injury. After the majority of corn rootworm larvae had finished feeding on corn roots, roots were dug to assess feeding injury. Roots were dug August 4, 2022. Prior to leaving the field, all roots were labeled with study name and plot number using a permanent marker. On August 9, roots were cleaned at the Iowa State Johnson Farm's root washing station. Roots first were soaked in water for 2 to 8 hours, then washed with a hose to remove any remaining soil. After being washed, roots were evaluated for rootworm feeding injury following the Iowa State Node Injury Scale (0-3) (Table 2).

Node Injury Scale (0-3)

0.00–No feeding injury (lowest rating that can be given).

1.00–One node (circle of roots), or the equivalent of an entire node, pruned to within 1.5 in. of the stalk or soil line

2.00–Two nodes pruned

3.00–Three or more nodes pruned. (Highest rating that can be given)

Injury in between complete nodes pruned was noted as the proportion of the node injured (e.g., 1.50 = one and a half nodes pruned and 0.25 = one quarter of one node pruned).

Product consistency. Percent product consistency was calculated as the percentage of times a treatment limited feeding injury to 0.25 nodes or less (greater injury may result in economic yield loss, especially when plants are moisture stressed).

Lodging counts. Lodging counts were collected October 14 prior to harvest. A plant was considered lodged if it was leaning greater than 30 degrees from vertical. Lodging counts were taken alongside the stand counts collected on the same date. The percent lodging was calculated by dividing the number of lodged plants by the total stand in each plot, then multiplied by 100 (Table 3).

Yields. This study was machine harvested October 27 with a modified John Deere 9450 plot combine owned by Iowa State University. Weight (pounds) and percent moisture were recorded with a high capacity grain gauge, using the HarvestMaster brand harvest data collection system. These measurements were converted to bushels per acre of No. 2 shelled corn (56 pounds per bushel) at 15.5% moisture in Microsoft Excel (Table 4).

Data analysis. Data were analyzed with analysis of variance (ANOVA) in SAS Enterprise Guide 7.1. The treatment means were compared using LSMEAN procedure with an experiment-wise error rate of P < 0.05.

Table 2. 2022 average root injury and product consistency. Bruner farm, Boone county.[1]

Treatment[2]	Formulation	Rate[3]	Placement[4]	Node-Injury[5,6,8]	Product Consistency[7,8]
Capture LFR	1.50 SC	0.98	Furrow	0.47[a]	30[ab]
Force Evo	2.10 EC	0.57	Furrow	0.63[a]	10[ab]
Ampex SC(2055)[9]	1.71 SC	0.68	Furrow	0.73[a]	45[a]
Ampex SC(2055)[9]	1.71 SC	0.46	Furrow	0.88[ab]	5[ab]
Untreated check				1.43[b]	0[b]

[1]Planted June 1; evaluated August 9.
[2]Non-CRW Bt = an absence of any Bt trait targeting corn rootworm.
[3]All insecticides listed as fluid ounces per 1,000 row feet.
[4]Furrow = All insecticides were applied as liquids in furrow at planting time.
[5]Means based on 20 observations (5 roots/2 rows × 4 replications).
[6]Iowa State Node-Injury scale (0-3). Number of full or partial nodes completely eaten.
[7]Product consistency = percentage of times nodal injury was 0.25 (¼ node eaten) or less.
[8]Significant difference between the treatment means for both Node-Injury and Product Consistency (ANOVA, P < 0.05).
[9]Ampex currently is not registered by the EPA and is an experimental insecticide.

Table 3. 2022 Average Lodging Count. Bruner Farm, Boone County.[1]

Treatment[2]	Formulation	Rate[3]	Placement[4]	Lodging Counts[5,6]
Ampex SC(2055)[7]	1.71 SC	0.68	Furrow	0.0[a]
Force Evo	2.10 EC	0.57	Furrow	0.0[a]
Ampex SC(2055)[7]	1.71 SC	0.46	Furrow	0.0[a]
Capture LFR	1.50 SC	0.98	Furrow	0.8[ab]
Untreated check				3.1[b]

[1]Planted June 1; evaluated October 14.
[2]Non-CRW Bt = An absence of any Bt trait targeting corn rootworm.
[3]All insecticides listed as fluid ounces per 1,000 row feet.
[4]Furrow = All insecticides were applied as liquids in furrow at planting time.
[5]Data presented as percentage of plants from the October 14, stand count that were lodged.
[6]Significant differences between means (ANOVA, P < 0.05).
[7]Ampex currently is not registered by the EPA and is an experimental insecticide.

Table 4. 2022 Average Yield. Bruner Farm, Boone County.[1]

Treatment[2]	Formulation	Rate[3]	Placement[4]	Bushels/ Acre[5,6]
Ampex SC(2055)8	1.71 SC	0.68	Furrow	189.6[a]
Ampex SC(2055)8	1.71 SC	0.46	Furrow	141.5[ab]
Capture LFR	1.50 SC	0.98	Furrow	137.5[ab]
Force Evo	2.10 EC	0.57	Furrow	133.8[ab]
Untreated Check				103.7[b]

[1]Planted June 1; harvested October 27.
[2]Non-RW Bt = An absence of any Bt trait targeting corn rootworm.
[3]All insecticides listed as fluid ounces per 1,000 row feet.
[4]Furrow = All insecticides were applied as liquids in furrow at planting time.
[5]Means based on 4 observations (2-row treatment × 30 row-feet/treatment × 4 replications).
[6]Significant differences between means (ANOVA, P < 0.05).
[7]Yields converted to 15.5% moisture.
[8]Ampex currently is not registered by the EPA and is an experimental insecticide.

Results and Discussion

Researchers observed moderate pressure from larval corn rootworm in this study, with the untreated check suffering an average of 1.43 nodes of root injury. With the exception of the low rate of the experimental product Ampex, all products significantly reduced larval injury from corn rootworm by at least 50% (Table 1). There were no differences in stand counts and very little lodging in this study (Tables 2 and 3). The highest rate of the experimental insecticide Ampex significantly increased yield compared with the untreated check, but no other differences in yield were observed (Table 4).

Acknowledgements

We thank Valent for providing the funding for this study. We are grateful to Mike Fiscus and his staff for their assistance with this research.

Additional Information

Annual reports for the Iowa Evaluation of Insecticides and Plant-Incorporated Protectants are available online through the Department Plant Pathology, Entomology, and Microbiology at Iowa State University, ent.iastate.edu/dept/faculty/gassmann/rootworm.

LAiYERS: Land Management for Improved Yields, Environmental Resilience, and Sustainability

Natasha Hoover—research scientist, Department of Agricultural and Biosystems Engineering

Michelle Soupir—professor, Department of Agricultural and Biosystems Engineering

Daniel Anderson—associate professor, Department of Agricultural and Biosystems Engineering

Ramesh Kanwar—professor, Department of Agricultural and Biosystems Engineering

Twenty-seven individually tile drained one-quarter-acre plots were established at Iowa State University's Agricultural and Biosystems Engineering Research Farm in spring 2021. Nine system treatments were assigned in triplicate to the research plots (Figure 1). The site was designed for comparison of litter and land management practices, with immediate and ongoing goals of evaluating crop yield response to poultry litter application timing and cover crops, and water quality impacts with reduced tillage practices.

All plots are managed using strip-till. Treatments include manure or chemical fertilizer (UAN) application before corn, with early winter or spring poultry manure at 150 lb. N/acre; spring UAN at 150 lb. N/acre; balance poultry manure with UAN with an early winter poultry manure at 150 lb. N/acre followed by UAN at 150 lb. N/acre; and split UAN with 75 lb. N/acre spring applied and 75 lb. N/acre as sidedress. The first poultry manure treatments were applied for the 2022 growing season, with early winter (EW) manure applied December 3, 2021, and spring manure applied April 26, 2022. All fertilizer treatments were applied at a target application rate of 150 lb. N/acre.

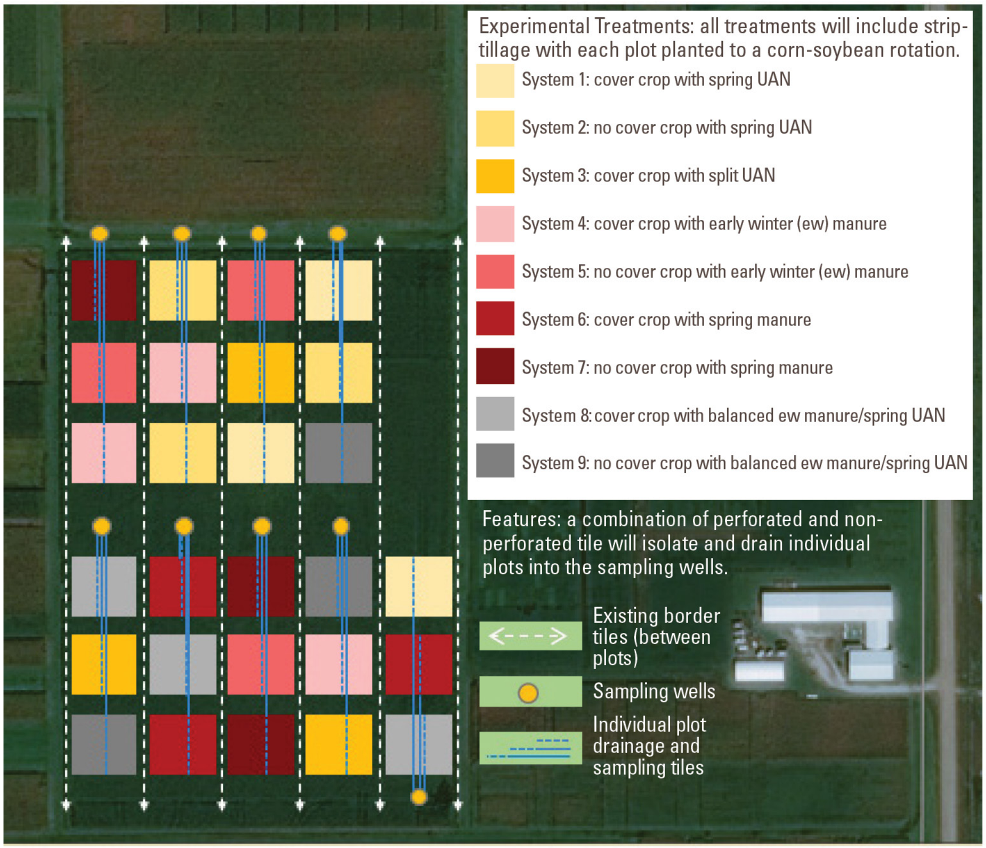


Figure 1. Illustration of the LAiYERS site plot layout and features.

Materials and Methods

Installation. Tile installation and plot establishment at Field 40 (LAiYERS) was completed in June 2021. Drainage tile was installed centrally along the length of each plot, with perforated tile installed to drain an individual plot in line with solid tile to transport the monitored drainage further to the sampling wells where needed. Each sampling well houses three individual plot sampling basins. Electrical installation to each sampling well is scheduled to be completed in March 2023 to allow for continuous flow monitoring and flow weighted sample collection of the individual plot basins housed in the sampling wells.

Results

The crop rotation at the site is corn-soybean, with soybean planted in Year 1 (2021) and corn planted in Year 2 (2022). In the first year, baseline soil health analysis was conducted, and all plots were planted to soybean. Because of dry conditions and late planting, the first year soybean yields were low (average yield 19 bushels/acre) and water samples were not collected (tiles did not flow). Tile flow was monitored in 2022, and drainage samples were collected and analyzed. Early results hint at the potential for combined management practices of spring manure and cover crops to positively impact water quality, but continued monitoring is needed to identify treatment effects. Additionally, there was no trend in corn yield impacts with the cover crop treatments. Moving forward, this study will provide practical guidance to farmers interested in maximizing yield, resiliency to varying climatic conditions, and protecting downstream water quality.

Acknowledgements

This research was supported through grants from the Iowa Egg Council and the Iowa Soybean Association, with poultry litter donated by Farm Nutrients.

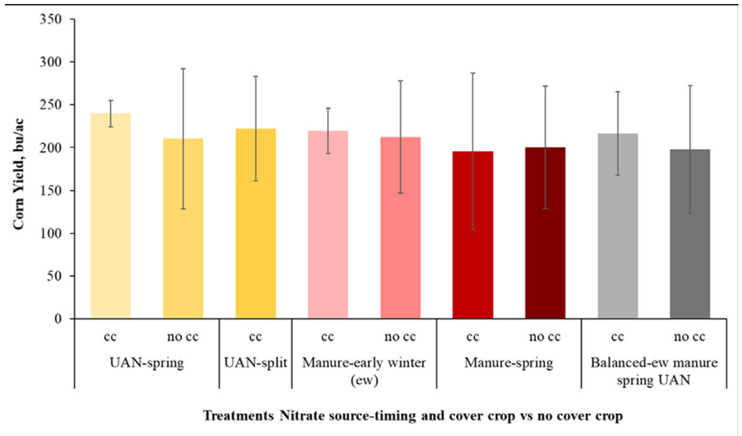


Figure 2. A comparison of average corn yields with combined fertilizer/ manure management and cover crops. Yield results were similar for all treatments. Cover crops did not appear to have a large effect on crop yields, with similar or even higher yields harvested at the cover cropped plots. Error bars denote +/- one standard deviation.

Table 1. Median NOx (nitrate+nitrite) concentrations with treatment for the 2022 drainage season. Samples were collected from early April through early July. Early results indicate lower NOx-N concentrations with the spring manure treatments, although these differences were not significant.

Nitrate source-timing	Cover crop (yes/no)	System Treatment	NO_x (mg N/L)
UAN-spring	yes	1	13.88
	no	2	12.61
UAN-split	yes	3	13.30
Manure-early winter (ew)	yes	4	12.84
	no	5	14.40
Manure-spring	yes	6	12.07
	no	7	12.00
Balanced-ew manure spring UAN	yes	8	14.10
	no	9	13.60

Greensnap and Stand Reduction Effects on Corn Yield

Mark Licht—associate professor, Department of Agronomy

Fernando Marcos—research scientist, Department of Agronomy

Objective

Determine the effects of greensnap and stand reduction on corn yield and kernel weight.

Materials and Methods

Site-Year 1: Ames (AEA) | Crop Year–2019

Soil type	Nicollet, Webster
Previous crop	Soybean
Cultivar	P0688AM
Planting date	June 04, 2019
Row spacing	30-in.
Seeding rate	36,000 seeds/acre
Tillage	Field cultivator in the spring
Fertilizer	150 lb./acre as MESZ (12-40-0) in the fall
Nitrogen	185 lb. N/acre as NH3 (32-0-0) in the spring
Harvest date	October 31, 2019
Experimental design	Randomized complete block design
Replications	Four
Treatments	Both the greensnap (stalk breakage above the ear) and stand reduction (stalk breakage below the ear) 'events' had three timings (TM: V16, VT/R1, R2 in 2019) and four severities (SV: 0%, 25%, 50% and 75%).

Site-Year 2: Ames (AEA) | Crop Year–2021

Soil type	Nicollet, Webster
Previous crop	Soybean
Cultivar	P0688AM
Planting date	May 06, 2021
Row spacing	30-in.
Seeding rate	36,000 seeds/acre
Tillage	Field cultivator in the spring
Fertilizer	150 lb./acre as MESZ (12-40-0) in the fall
Nitrogen	185 lb. N/acre as NH3 (32-0-0) in the spring
Harvest date	October 15, 2021
Experimental design	Randomized complete block design
Replications	Four
Treatments	Both the greensnap (stalk breakage above the ear) and stand reduction (stalk breakage below the ear) 'events' had three timings (TM: V13, V16, VT/R1 in 2020) and four severities (SV: 0%, 25%, 50% and 75%).

Site-Year 3: Ames (AEA) | Crop Year–2022

Soil type	Nicollet, Webster
Previous crop	Soybean
Cultivar	P0688AM
Planting date	May 23, 2022
Row spacing	30-in.
Seeding rate	36,000 seeds/acre
Tillage	Field cultivator in the spring
Fertilizer	150 lb./acre as MESZ (12-40-0) in the fall
Nitrogen	185 lb. N/acre as NH3 (32-0-0) in the spring
Harvest date	October 21, 2022
Experimental design	Randomized complete block design
Replications	Four
Treatments	Both the greensnap (stalk breakage above the ear) and stand reduction (stalk breakage below the ear) 'events' had three timings (TM: V13, V16, VT/R1 in 2022) and four severities (SV: 0%, 25%, 50% and 75%).

Results

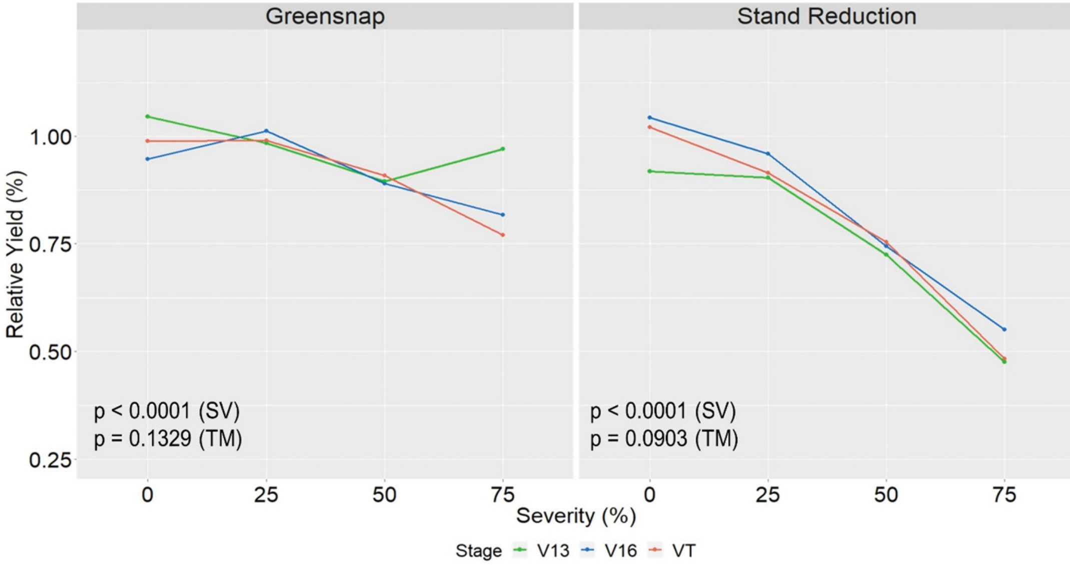


Figure 1. Relative yield at 15% moisture across years in both 'events' (2019, 2021, 2022).

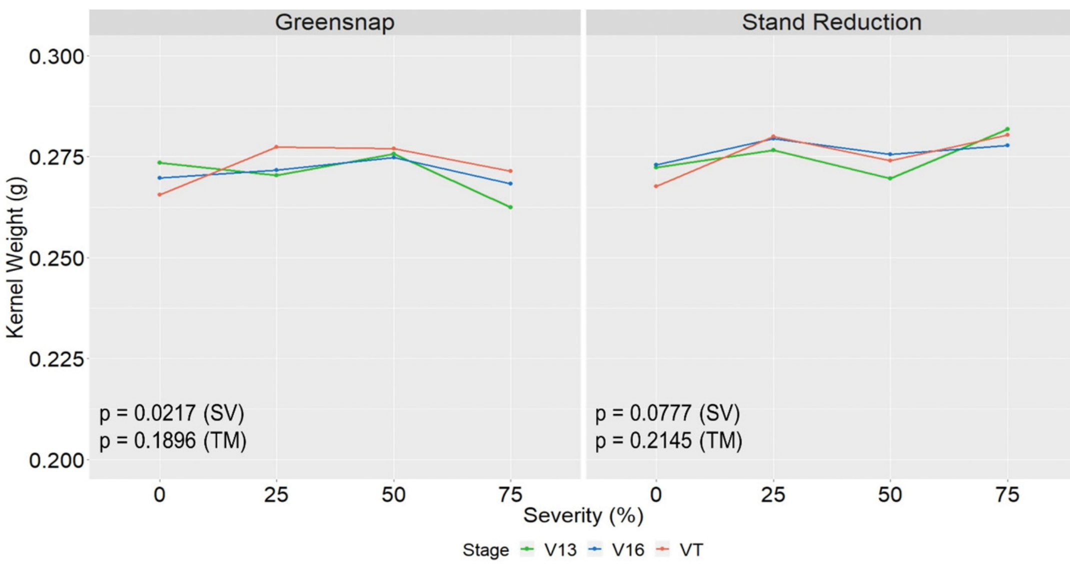


Figure 2. Kernel weight across years in both 'events' (2019, 2021, 2022).

Key Takeaways

- Across years, treatment severity significantly affected corn yields: however, the stage of the event did not affect corn yield. For both events, yield loss was less than 1% for each percent severity, as previously assumed.
- Generally, kernel weight increased for greensnap severity of 25% and 50% but was not affected by timing of greensnap. The stand reduction event had moderate kernel weight significance where the 75% severity was greater than the 0% severity.

Acknowledgements

This project was funded by National Crop Insurance Services.

Long-Term Tillage and Crop Rotation Trial

Mark Licht—associate professor, Department of Agronomy

Fernando Marcos—research scientist, Department of Agronomy

Objective

Evaluate the long-term effects of tillage systems and crop rotations on grain yields.

Materials and Methods

Site-Year 1: Ames (AEA) | Crop Year–2021

Soil type	Nicollet, Harps, Canisteo
Previous crop	Varied by crop rotation
Hybid/Variety	Corn–P1185Q
Planting date	May 6, 2021
Row spacing	30-in.
Seeding rate	Corn–34,000
Tillage	ST, CP, DR, MP–November 9, 2020 preceding fall treatments
Fertilizer	Applied in fall 2020 for both trials; analysis of 17-58-87-14.5-1.45 applied in early November. Phosphorus was applied in the MESZ formulation.
Nitrogen	32% UAN applied with planter at 78 lb. N/acre on all plots. As sidedress on June 8, 2021, at 100 lb./acre on corn following corn plots, and 78 lb./acre on corn following soy plots to achieve total nitrogen credit of 175 lb./acre
Harvest date	September 29, 2021
Experimental design	Randomized complete block design
Replications	Four
Treatments	No-tillage (NT), strip-tillage (ST), chisel plow (CP), deep rip (DR), moldboard plow (MP)

Site-Year 2: Ames (AEA) | Crop Year–2022

Soil type	Nicollet, Harps, Canisteo
Previous crop	Varied by crop rotation
Hybid/Variety	Corn–P1108Q; soybean–21EE62
Planting date	Corn–May 24, 2022; soybean–June 21, 2022
Row spacing	30-in.
Seeding rate	Corn–34,000; soybean–140,000
Tillage	ST, CP, DR–November 9, 2021; MP–November 10, 2021; leveled off with field cultivator in CP, DR, and MP early May, 2022, and once more before planting.
Fertilizer	MESZ phosphorus applied to both plots April 27, 2022 at 200 lb./acre; potash applied to both plots April 27, 2022 at 422 lb./acre; effective actual rate of 24-80-253-20-2 of N-P-K-S-ZN
Nitrogen	UAN 32% at 70 lb./acre applied May 24, 2022 and 95 lb./acre sidedress June 21, 2022
Harvest date	October 20, 2022
Experimental design	Randomized complete block design
Replications	Four
Treatments	No-tillage (NT), strip-tillage (ST), chisel plow (CP), deep rip (DR), moldboard plow (MP)

Results

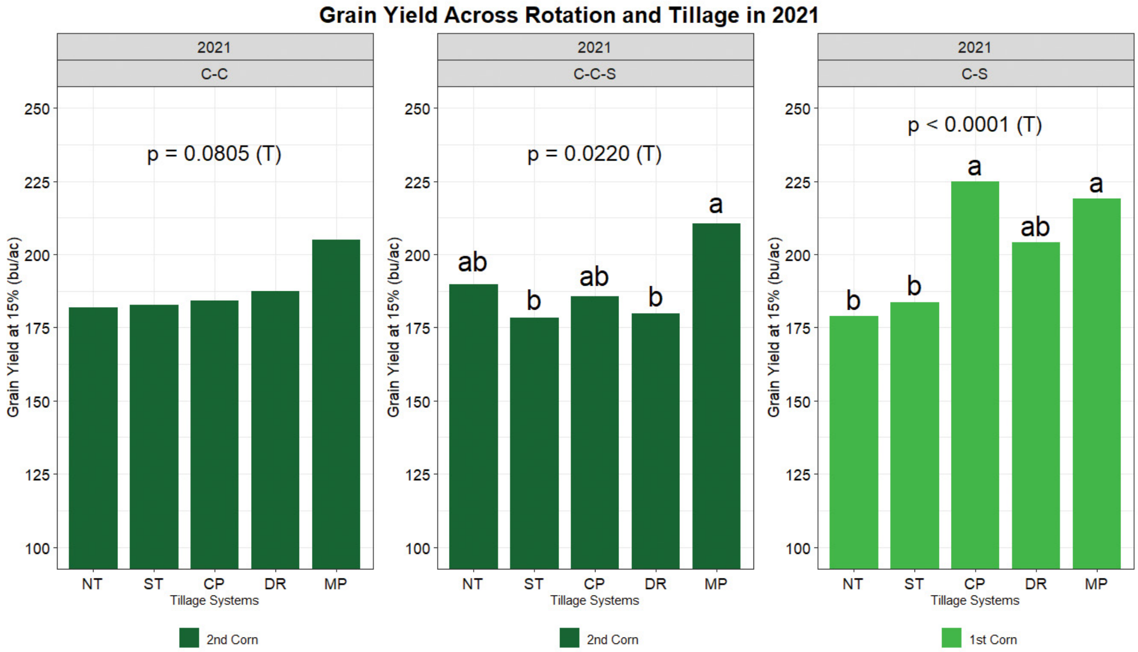


Figure 1. Grain yield in 2021 from the tillage systems within each crop rotation. Yields that are significantly different at P < 0.05 have different letters.

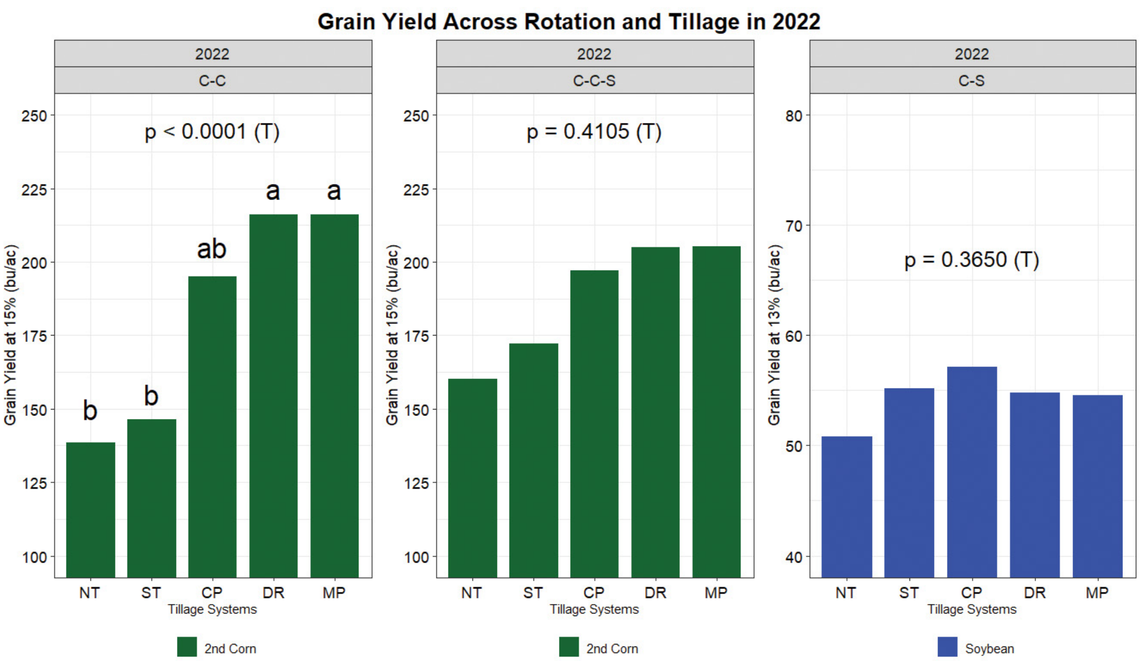


Figure 2. Grain yield in 2022 from the tillage systems within each crop rotation. Yields that are significantly different at P < 0.05 have different letters.

Key Takeaways

- In both years, the second year corn and continuous corn had a trend of improved yields with more intensive tillage practices. In two of them, MP was statistically superior to the other tillage practices (p = 0.0220 in 2021 and p < 0.0001 in 2022).
- The corn-soybean rotation in 2021 also had higher corn yield with the MP tillage system, however, in this rotation-year, CP performance also was superior (p < 0.0001).
- There was no improvement from tillage practices on soybean grain yield in 2022. Although CP performed higher than the other practices, it was not statistically significant (p = 0.3650).

Small Grain Variety Trials

Stefan Gailans—Practical Farmers of Iowa

Michael Fiscus—farm superintendent, Agricultural Engineering/Agronomy Farm

Careful management and proper variety selection can make small grains profitable in crop rotations due to low input requirements and beneficial effects on succeeding crops. When grown as a cash crop, cereal rye and oats can be marketed for cover crop seed, grain, straw, forage, hay, or haylage. The mid-summer harvest allows for a myriad of field management options for the remainder of the season, such as mid-season manure application, or the establishment of a perennial forage crop.

Practical Farmers of Iowa has been collaborating with Iowa State Research Farms to trial small grain varieties since 2015. This past year, cereal rye and oats were trialed at the Ag Engineering and Agronomy Research Farm. This was the second year cereal rye was trialed and the fourth year oats were trialed in this location.

Materials and Methods

Ten varieties of cereal rye (and one triticale variety) and 17 varieties of oats were trialed in 2022. Management information for each trial can be found in Table 1. No herbicides or insecticides were applied. Seed samples of non-hybrid varieties of rye and triticale from each location were sent to the Iowa State Seed Testing Laboratory for germination testing. Germination seed samples were pooled across replicates at each site: therefore, germination data are not analyzed statistically. Data were analyzed using JMP Pro 15 (SAS Institute Inc., Cary, North Carolina). Statistical significance is determined at $P \leq 0.10$ level (unless otherwise noted) and means separations are reported using Tukey's least significant difference (LSD).

Results

Rye yields ranged from 34 to 86 bushels/acre with an average of 59. The four hybrid rye varieties (Bono, Receptor, Serafino, Tayo) had the highest yield. Rye and triticale seed germination ranged from 89 to 96% with an average of 94% (Table 2).

Table 1. Management information for small grain variety trials.

	Cereal rye and triticale trial	Oat trial
Previous crop	Soybean	Soybean
Replications	3	3
Harvested plot size	5 ft. × 61 ft.	5 ft. × 49 ft.
Fertilizer applied	30 lb. N/ac., 11 lb. P/ac., 40 lb. K/ac. and 25 lb. S/ac. on Apr. 11	30 lb. N/ac., 11 lb. P/ac., 40 lb. K/ac. and 25 lb. S/ac. on Apr. 11
Tillage	None	None
Planting date	Oct. 8, 2021	Apr. 19
Row spacing	7.5 in.	7.5 in.
Seeding rate	Variable to achieve target planting population of 23 seeds/ft.^{2}	4 bu./ac.
Seeding depth	1 in.	1 in.
Harvest date	July 29	July 29

Table 2. Yield, test weight, plant height, percent lodging, and germination of cereal rye and triticale varieties.

	Yield			Plant height at harvest, in.	Lodging at harvest, %	Seed germination, %
	bu./ac.	% of site avg.	Test weight lb./bu.			
Aroostook	57	96				
Bono	74	125	55	43	5	0
Danko	59	99	55	49	12	94
Elbon	34	58	54	51	53	96
Hazlet	50	85	54	50	12	95
ND Dylan	57	97	53	53	48	94
ND Gardner	41	69	53	55	68	94
Receptor	82	138	56	46	17	0
Serafino	72	121	55	44	10	0
Spooner	46	77	54	51	25	94
Tayo	86	145	54	46	7	0
Tulus (trit.)	53	90	44	37	0	89
LSD(90%)	23	0	3	4	20	0
MEAN	59	0	54	48	22	94

By response variable, if the difference between any two entries is greater than the least significant difference (LSD), the entries are considered statistically different with 90% confidence.

Oat yields ranged from 80 to 110 bushels/acre with an average of 94. Test weight ranged from 33.8 to 40.3 lb./bushel. Three varieties had a test weight above the milling threshold: 38 lb./bushel. The highest yielding variety was Reins. Antigo had the highest test weight (Table 3).

Further information about the trials, such as the characteristic of each variety and their source, can be found ont he Practical Farmers of Iowa website:

[Cereal Rye and Tritcate Trial](practicalfarmers.org/research/cereal-rye-and-triticale-variety-trial-2022)
practicalfarmers.org/research/cereal-rye-and-triticale-variety-trial-2022

[Oat Variety Trial](practicalfarmers.org/research/oat-variety-trial-2022)
practicalfarmers.org/research/oat-variety-trial-2022

Acknowledgements

This work is supported by the Agriculture and Food Research Initiative, grant number F9000315202081 from the USDA National Institute of Food and Agriculture. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the views of the U.S. Department of Agriculture. Seed donated by Albert Lea Seed House, KWS, Welter Seed and Honey Co., Meridian Seeds, SDSU Seed Foundation, and Zabel Seed.

Table 3. Yield, test weight, plant height and percent lodging of oat varieties.

	Yield					
	bu/ac.	**% of site avg.**	**5-year. average, bu/ac.**	**Test weight, lb./bu.**	**Plant height at harvest, in.**	**Lodging at harvest, %**
Antigo	100	107	85			
CS Camden	82	87	87	33.8	29	13
Deon	87	93	90	35.7	33	15
Esker 2020	92	99	101	34.5	32	15
Goliath	101	108	92	36.3	37	18
Hayden	83	88	86	37.3	32	0
Jerry	101	107	82	37.3	31	0
MN Pearl	88	94	95	37.1	31	0
Morton	87	93	95	35.3	35	0
Natty	97	103	88	35.9	34	2
Reins	110	117	98	38.8	27	0
Rushmore	98	105	113	37.8	31	0
Saddle	95	101	99	36.3	29	0
SD Buffalo	105	112	--	35.5	33	0
Shelby 427	87	93	82	37.4	34	0
Sumo	80	85	82	39.2	33	0
Warrior	98	105	103	35.4	29	0
MEAN	94	0	0	37.0	32	0
LSD (90%)	38	0	0	3.7	5	0

By response variable, if the difference between any two entries is greater than the least significant difference (LSD), the entries are considered statistically different with 90% confidence.
5-year average yields are listed for varieties trialed at least twice in the past seven years at this location.

Burndown and Residual Weed Control in No-Tillage Enlist Soybean

Prashant Jha — professor, Department of Agronomy

Damian Franzenburg—research scientist, Department of Agronomy

Iththiphonh Macvilay—agricultural specialist, Department of Agronomy

The purpose of this study was to evaluate weed control in no-tillage Enlist Soybean for various herbicides in programs with preplant plus postemergence applications.

Materials and Methods

The study was established using a randomized complete block design with three replications. The crop rotation was soybean following soybean. The pre-plant seedbed was left untilled from the 2020 crop season. Early preplant (EPP) treatments were applied May 10 delivering 15 gal./acre with 11015TTI and 11015TT tips at 35 psi. Glyphosate, glufosinate, and 2,4-D tolerant soybean, Syngenta NKS28-E3, was planted at 154,000 seeds/acre in 30-in. rows May 24. Postemergence (POST) treatments were applied June 10, delivering 15 gal./acre with 11015TTI tips at 35 psi. to soybean at the VE growth stage. Weed species in the study included common waterhemp, common ragweed, common lambsquarters and marestail. Common waterhemp and marestail were 0.25 and 3 in. tall, at densities of 0.5 and 1 plant/ft.^{2} at the POST application, respectively. Common ragweed and common lambsquarters generally were not present in the POST treated plots at the time of application. Visual estimates of percentage soybean injury and weed control during the growing season were compared with an untreated control; 0% = no injury or control and 99% = complete crop kill or control.

Summary

None of the EPP treatments caused soybean injury up to the POST application June 10 (data not shown). POST Enlist One + Roundup PowerMAX + Perpetuo + Select Max treatments caused 15% injury June 18, eight days after treatment (DAA).

Common waterhemp had not emerged at the time of the burndown applications. EPP Reviton and Sharpen did not provide residual control (Table 1). However, EPP

Table 1. Burndown and Residual Weed Control in No-Tillage Enlist Soybean, 2021.

Treatment	Rate	Appln timing	Abuth[c] July 10	Amata July 10	Cheal July 10	Ipohe July 10
	product/acre		% weed control			
Untreated			0	0	0	0
Reviton + Destiny HC	2.0 fl oz + 1.0% v/va	EPP	10	91	99	73
Reviton + Roundup PowerMAX + AMSb + Destiny HC	1.0 fl oz + 32.0 fl oz + 8.5 lb/100 gal + 1.0% v/v	EPP	0	96	99	92
Sharpen + Roundup PowerMAX + AMS + Destiny HC	1.5 fl oz + 32.0 fl oz + 8.5 lb/100 gal + 1.0% v/v	EPP	47	97	99	98
Reviton + Roundup PowerMAX + AMS + Destiny HC + Zone Elite	1.0 fl oz + 32.0 fl oz + 8.5 lb/100 gal + 1.0% v/v 25.0 fl oz +	EPP	99	90	99	63
Enlist One + Roundup PowerMAX + Fierce EZ + Induce + (Enlist One + Roundup PowerMAX + Perpetuo + Select Max + AMS + Induce)	1.0 pt + 32.0 fl oz + 6.0 fl oz + 0.25% v/v (1.0 pt + 32.0 fl oz + 6.0 fl oz + 9.0 fl oz + 1.5 lb + 0.25% v/v)	EPP + (POST)	99	99	99	93
Enlist One + Roundup PowerMAX + First Rate + Fierce EZ + Induce +	1.0 pt + 32.0 fl oz + 0.6 oz wt + 6.0 fl oz + 0.25% v/v)	EPP +	99	99	99	92
(Enlist One + Roundup PowerMAX + Perpetuo + Select Max + AMS + Induce)	(1.0 pt + 32.0 fl oz + 6.0 fl oz + 9.0 fl oz + 1.5 lb + 0.25% v/v)	(POST)				
LSD (P=0.05)			19	10		11

[a]v/v = volume of product per volume tank mix.
[b]AMS = ammonium sulfate.
[c]Amata = common waterhemp, Ambel = common ragweed, Cheal = common lambsquarters
Erica = marestail

Reviton + Zone Elite, Fierce EZ and FirstRate + Fierce EZ gave complete control of common waterhemp through June 2, 23 days after application (DAA). Zone Elite continued to provide common waterhemp control (91%) as late as June 21, 42 DAA (Table 2). Fierce EZ and FirstRate + Fierce EZ continued to provide complete control.

All EPP treatments gave similarly good burndown and residual control of common ragweed at 23 DAA, (at least 90%, Table 1). However, control began to break for EPP Reviton and Reviton + Zone Elite treatments (60–65%) by 42 DAA on June 21 (Table 2). Sharpen continued to provide good common ragweed control with 88% at 42 DAA, which was statistically similar to Fierce EZ and FirstRate + Fierce EZ EPP treatments that included POST Roundup PowerMAX + Perpetuo + Select Max.

All treatments provided excellent season-long common lambsquarters control with at least 96% as late as 42 DAA.

Reviton provided only 73% burndown control of marestail at 23 DAA (Table1). However, tank-mixing with Roundup PowerMAX provided 92% control. Adding Zone Elite for a three-way tank-mixture reduced marestail control, though with only 63% (Table 1). EPP Sharpen + Roundup PowerMAX, Enlist One + Roundup PowerMAX + Fierce EZ and Enlist One + Roundup PowerMAX + FirstRate + Fierce EZ gave 98%, 93% and 92% control, respectively. The two-pass treatments maintained that level of control through June 21, while marestail control with the one-pass treatments generally decreased, with the exception of EPP Sharpen + Roundup PowerMAX (Table 2).

Acknowledgements

We thank Central Iowa Research Farms manager Kent Berns and farm staff for their assistance with this study. Funding for this work was provided by Helm Agro US Inc. and Valent USA Corporation.

Table 1. Burndown and Residual Weed Control in No-Tillage Enlist Soybean, 2021.

Treatment	Rate	Appln timing	Abuth[c] July 10	Amata July 10	Cheal July 10	Ipohe July 10
	product/acre		% weed control			
Untreated			0	0	0	0
Reviton + Destiny HC	2.0 fl oz + 1.0% v/va	EPP	23	60	98	63
Reviton + Roundup PowerMAX + AMSb + Destiny HC	1.0 fl oz + 32.0 fl oz + 8.5 lb/100 gal + 1.0% v/v	EPP	0	65	96	87
Sharpen + Roundup PowerMAX + AMS + Destiny HC	1.5 fl oz + 32.0 fl oz + 8.5 lb/100 gal + 1.0% v/v	EPP	27	88	99	98
Reviton + Roundup PowerMAX + AMS + Destiny HC + Zone Elite	1.0 fl oz + 32.0 fl oz + 8.5 lb/100 gal + 1.0% v/v 25.0 fl oz +	EPP	91	65	99	50
Enlist One + Roundup PowerMAX + Fierce EZ + Induce + (Enlist One + Roundup PowerMAX + Perpetuo + Select Max + AMS + Induce)	1.0 pt + 32.0 fl oz + 6.0 fl oz + 0.25% v/v (1.0 pt + 32.0 fl oz + 6.0 fl oz + 9.0 fl oz + 1.5 lb + 0.25% v/v)	EPP + (POST)	99	99	99	93
Enlist One + Roundup PowerMAX + First Rate + Fierce EZ + Induce + (Enlist One + Roundup PowerMAX + Perpetuo + Select Max + AMS + Induce)	1.0 pt + 32.0 fl oz + 0.6 oz wt + 6.0 fl oz + 0.25% v/v) (1.0 pt + 32.0 fl oz + 6.0 fl oz + 9.0 fl oz + 1.5 lb + 0.25% v/v)	EPP + (POST)	99	99	99	98
LSD (P=0.05)			24	11	3	12

[a]v/v = volume of product per volume tank mix.
[b]AMS = ammonium sulfate.
[c]Amata = common waterhemp, Ambel = common ragweed, Cheal = common lambsquarters
Erica = marestail

Engenia Prime versus Competitors for Early Postemergence Weed Control in Dicamba Tolerant Soybean

Prashant Jha — professor, Department of Agronomy

Damian Franzenburg—research scientist, Department of Agronomy

Iththiphonh Macvilay—agricultural specialist, Department of Agronomy

The purpose of this study was to compare postemergence herbicide programs for crop injury and weed control in dicamba-tolerant soybean.

Materials and Methods

The study was established using a randomized complete block design with three replications. The crop rotation was soybean following corn. The pre-plant seedbed was prepared with a chisel plow in the fall and field cultivator prior to planting in the spring. XtendFlex Soybean, Asgrow AG22XF1, was planted at 154,000 seeds/acre in 30-in. rows May 26. Early postemergence (EPOST) treatments were applied June 10 to VE soybean delivering 15 gal./acre with 11015TTI and 11015TT tips at 35 psi. Weed species in the study included velvetleaf, common waterhemp, common lambsquarters, and ivyleaf morningglory. The common waterhemp population in the trial was very resistant to glyphosate. Weed sizes ranged from 0.25 to 1.0 in. across all weeds. Average population densities for velvetleaf and ivyleaf morningglory were 8 and 3 plants per plot, respectively. Common waterhemp and common lambsquarters were at 12 and 2 plants per $ft.^2$, respectively. Visual estimates of percent soybean injury and weed control during the growing season were compared with an untreated control; 0% = no injury or control, and 99% = complete crop kill or control.

Summary

Summarized in Tables 1 and 2 are the results of the study. All herbicide treatments caused 10% injury to soybean and gave complete burndown control of all weeds at 15 days after the EPOST application (data not shown). However, by July 10, 30 days after application (DAA), Tavium Plus VaporGrip Technology gave significantly lower residual velvetleaf control than Engenia Prime and Xtendimax With VaporGrip Technology + Warrant with 88% compared with 99% and 96%, respectively (Table 1).

Table 1. Engenia Prime vs. Competitors for Early Postemergence Weed Control in Dicamba Tolerant Soybean.

Treatment	Rate	Appln timing	Abuth[c] July 10	Amata July 10	Cheal July 10	Ipohe July 10
	product/acre		% weed control			
Untreated			0	0	0	0
Engenia Prime + Roundup PowerMAX + Sentris + Induce	16.0 fl.oz. + 32.0 fl.oz.+ 8.0fl.oz.+ 0.25% v/v[a]	EPOST	99	83	99	95
Xtendimax with VaporGrip Technology + Warrant + Roundup PowerMAX + Sentris + Induce	22.0 fl.oz. + 48fl.oz. + 32.0 fl.oz.+ 8.0 fl.oz.+ 0.25% v/v	EPOST	96	88	99	65
Tavium Plus VaporGrip Technology + Roundup PowerMax + Volt-Edge + Induce	56.5 fl.oz. + 32.0fl.oz. + 20.0 fl.oz.+ 0.25% v/v	EPOST	88	83	99	60
Prefix +	32.0 fl.oz. +	EPOST	92	83	93	33
Roundup PowerMAX + COC[b] Anthem Maxx + Roundup PowerMAX + COC	32.0 fl.oz.+ 1.0% v/v 3.25 fl.oz. + 32.0fl.oz. + 1.0% v/v	EPOST	94	43	96	57
LSD (P=.05)			8	11	5	10

[a]v/v = volume of product per volume tank mix.
[b]COC = Prime Oil Crop Oil Concentrate
[c]Abuth = velvetleaf, Amata = common waterhemp, cheal = common lambsquarters, ipohe = ivyleaf morningglory

Prefix and Anthem Maxx gave similar velvetleaf control with 92% and 94%, respectively. Velvetleaf control remained unchanged on July 30 for Engenia Prime, Xtendimax with VaporGrip Technology + Warrant and Anthem Maxx while decreasing for Tavium Plus VaporGrip Technology and Prefix (Table 2).

Common waterhemp control at 30 and 50 DAA was 83-88% and 72-83%, respectively, for Engenia Prime, Xtendimax with VaporGrip Technology + Warrant, Tavium Plus VaporGrip and Prefix. Anthem Maxx gave 43% and 33% common waterhemp control for 30 and 50 DAA, respectively.

Common lambsquarters control by the herbicide treatments were 93-99% and 92-99% at 30 and 50 DAA, respectively.

Engenia Prime provided 95% ivyleaf morningglory control on July 10. Xtendimax with Vaporgrip Technology + Warrant, Tavium Plus VaporGrip Technology and Anthem Maxx gave 57-65%, and Prefix gave 33% ivyleaf morningglory control. By 50 DAA, control across treatments dropped only 3-7% for all treatments.

Acknowledgements

We thank Central Iowa Research Farms manager Kent Berns and farm staff for their assistance with this study. Funding for this work was provided by BASF Corporation.

Table 2. Engenia Prime versus Competitors for Early Postemergence Weed Control in Dicamba Tolerant Soybean.

Treatment	Rate	Appln timing	Abuth[c] July 10	Amata July 10	Cheal July 10	Ipohe July 10
	product/acre		% weed control			
Untreated			0	0	0	0
Engenia Prime + Roundup PowerMAX + Sentris + Induce	16.0 fl.oz. + 32.0 fl.oz + 8.0 fl.oz + 0.25% v/v[a]	EPOST	99	72	99	90
Xtendimax With VaporGrip Technology + Warrant + Roundup PowerMAX + Sentris + Induce	22.0 fl oz + 48 fl.oz + 32.0 fl.oz + 8.0 fl.oz + 0.25% v/v	EPOST	96	83	99	58
Tavium Plus VaporGrip Technology + Roundup PowerMax + Volt-Edge + Induce	56.5 fl.oz + 32.0 fl.oz. + 20.0 fl.oz. + 0.25% v/v	EPOST	82	73	95	57
Prefix + Roundup PowerMAX + COC[b]	32.0 fl.oz. + 32.0 fl.oz. + 1.0% v/v	EPOST	85	78	92	27
Anthem Maxx + Roundup PowerMAX + COC	3.25 fl.oz. + 32.0 fl.oz. + 1.0% v/v	EPOST	94	33	98	53
LSD (P=.05)			12	14	5	12

[a]v/v = volume of product per volume tank mix.
[b]COC = Prime Oil Crop Oil Concentrate
[c]Abuth = velvetleaf, Amata = common waterhemp, cheal = common lambsquarters, ipohe = ivyleaf morningglory

One-Pass and Two-Pass Herbicide Program Comparisons for Weed Control in Dicamba and Glufosinate Tolerant Soybean

Prashant Jha — professor, Department of Agronomy

Damian Franzenburg—research scientist, Department of Agronomy

Iththiphonh Macvilay—agricultural specialist, Department of Agronomy

The purpose of this study was to evaluate crop injury and weed control for one-pass and two-pass herbicide programs that include residual weed control in both timings.

Materials and Methods

The study was established using a randomized complete block design with three replications. The crop rotation was soybean following corn. The pre-plant seedbed was prepared with a chisel plow in the fall and field cultivator prior to planting in the spring. XtendFlex Soybean, Asgrow AG22XF1, was planted at 154,000 seeds/acre in 30-in. rows June 3. Preemergence (PRE) herbicide treatments were applied June 4, delivering 15 gal/acre with 110015TTI tips at 35 psi. Postemergence (POST) treatments were applied June 23 to V3 soybean, delivering 15 gal./acre with 110015TT and 110015TTI tips at 35 psi. Weed species in the study included giant foxtail, velvetleaf, common waterhemp, and ivyleaf morningglory. Giant foxtail density at POST application was 1 plant/ft.^{2}, and the broadleaf weeds each averaged about eight plants/plot. Weeds were generally 4-6 in. tall. Visual estimates of percent corn injury and weed control during the growing season were compared with an untreated control; 0% = no injury or control, and 99% = complete crop kill or control.

Summary

Summarized in Tables 1 and 2 are the results of the study. Rainfall was very limited after planting, causing reduced weed emergence. Pre-herbicide treatments were not incorporated with significant rainfall for at least two weeks after application. None of the PRE treatments caused significant injury to soybean, and weed control was generally unacceptable because of very dry conditions. PRE herbicide treatments provided 63-75%, 47-50%, 60-67% and 0% control of giant foxtail, velvetleaf, common waterhemp, and ivyleaf morningglory, respectively (data not shown).

Treatments containing POST Roundup PowerMAX + Xtendimax wVGT + Perpetuo + Select Max and POST Scout + Perpetuo + Select Max caused 30-32% soybean injury on June 26, three days after POST (DAA), while POST Zidua + Liberty treatments caused 15% injury. Injury caused by the same treatments was still significant at 24 DAA with 20–22% and 13% injury, respectively, for the groups of treatments (data not shown).

Significant rainfall June 20 caused heavy weed emergence following the POST application. Table 1 shows burndown and residual weed control on July 10 (17 DAA). All treatments provided excellent giant foxtail control (96-99%) at 17 DAA. One-pass Zidua + Liberty gave significantly less giant foxtail control than the two-pass treatments at 37 DAA POST, though still at 93% (Table2).

Velvetleaf and ivyleaf morningglory control, each, were similar among all two-pass treatments at 17 DAA with 88-95% and 57-73% control, respectively. However, control of these two weeds by the POST Scout treatments broke to a greater degree, providing significantly less control of velvetleaf than the POST Roundup PowerMAX + Xtendimax wVGT when observed at 37 DAA. The one-pass Zidua + Liberty treatments generally gave significantly less control of these two weeds at both evaluation dates.

Common waterhemp control was similar for all treatments at 17 and 37 DAA, with the exception of POST Zidua + Liberty + Poly Tex giving significantly less control than all other treatments at 17 DAA and less control than the two-pass treatments at 37 DAA (Tables 1 and 2) .

Common waterhemp control was similar for all treatments at 17 and 37 DAA, with the exception of POST Zidua + Liberty + Poly Tex giving significantly less control than all other treatments at 17 DAA and less control than the two-pass treatments at 37 DAA (Tables 1 and 2) .

Acknowledgements

We thank Central Iowa Research Farms manager Kent Berns and farm staff for their assistance with this study. Funding for this research was provided by Valent USA Corporation and the Iowa Soybean Association.

Table 1. One-Pass and Two-Pass Herbicide Program Comparisons for Weed Control in Dicamba and Glufosinate Tolerant Soybean, 2022.

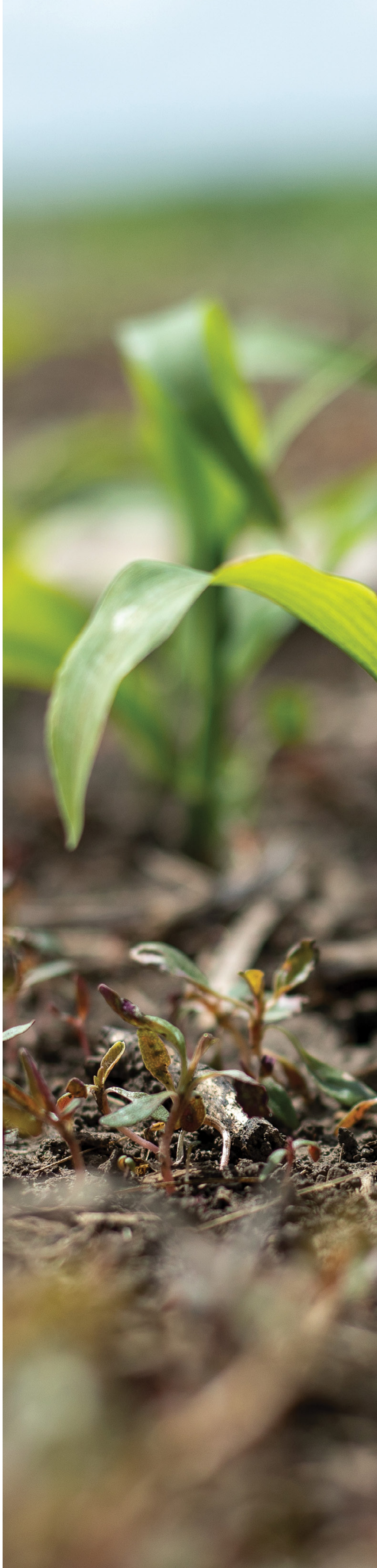
Treatment	Rate	Appln timing	Sefta[d] July 10	Abuth July 10	AMata July 10	Ipohe July 10
	product/acre		% weed control			
Untreated			0	0	0	0
Fierce EZ + (Roundup PowerMAX + Xtendimax wVGT[a] + Perpetuo + Select Max + Vaporgrip Xtra Agent + Intact + Induce)	6.0 fl. oz. + (32.0 fl. oz. + 22.0 fl. oz. + 6.0 fl. oz. + 9.0 fl. oz. + 20.0 fl. oz. + 0.5% v/v[b] + 0.25% v/v)	PRE + (POST)	96	95	99	70
Fierce MTZ SC + (Roundup PowerMAX + Xtendimax wVGT Perpetuo + Select Max + Vaporgrip Xtra Agent + Intact + Induce)	16.0 fl. oz. + (32.0 fl. oz. + 22.0 fl. oz. + 6.0 fl. oz. + 9.0 fl. oz. + 20.0 fl. oz. + 0.5% v/v + 0.25% v/v)	PRE + (POST)	99	93	99	73
Fierce EZ (Scout + Perpetuo + Select Max + Induce + N-Pak AMS Liquid[c])	6.0 fl. oz. + (32.0 fl. oz. + 6 fl. oz. + 9.0 fl. oz. + 0.25% v/v + 3.53 qt.)	PRE + (POST)	99	88	99	57
Fierce MTZ SC + (Scout + Perpetuo + Select Max + Induce + N-Pak AMS Liquid)	16.0 fl. oz. + (32.0 fl. oz. + 6 fl. oz. + 9.0 fl. oz. + 0.25% v/v + 3.53 qt.)	PRE + (POST)	99	92	99	67
Zidua SC + Liberty 280 SL + N-Pak AMS Liquid	3.0 fl. oz. + 32.0 fl. oz. + 3.53 qt.	POST	96	67	99	40
Zidua SC + Liberty 280 SL + N-Pak AMS Liquid + Poly Tex	3.0 fl. oz. + 32.0 fl. oz. + 3.53 qt. + 1.0% v/v	POST	98	70	93	40
LSD (P=0.05)			3	9	4	22

[a]Xtendimax wVGT = Xtendimax With Vaporgrip Technology.
[b]v/v = Volume of product per volume tank mix.
[c]N-Pak AMS liquid = ammonium sulfate.
[d]Setfa = giant foxtail, Abuth = velvetleaf, Amata = common waterhemp, Ipohe = ivyleaf morningglory

Table 2. One-Pass and Two-Pass Herbicide Program Comparisons for Weed Control in Dicamba and Glufosinate Tolerant Soybean, 2022.

Treatment	Rate	Appln timing	Setfa[d] July 30	Abuth July 30	Amata July 30	Ipohe July 30
	product/acre		% weed control			
Untreated			0	0	0	0
Fierce EZ + (Roundup PowerMAX + Xtendimax wVGT[a] + Perpetuo + Select Max + Vaporgrip Xtra Agent + Intact + Induce)	6.0 fl. oz. + (32.0 fl. oz. + 22.0 fl. oz. + 6.0 fl. oz. + 9.0 fl. oz. + 20.0 fl. oz. + 0.5% v/vb + 0.25% v/v)	PRE + (POST)	96	91	99	67
Fierce MTZ SC + (Roundup PowerMAX + Xtendimax wVGT Perpetuo + Select Max + Vaporgrip Xtra Agent + Intact + Induce)	16.0 fl. oz. + (32.0 fl. oz. + 22.0 fl. oz. + 6.0 fl. oz. + 9.0 fl. oz. + 20.0 fl. oz.+ 0.5% v/v + 0.25% v/v)	PRE + (POST)	98	90	98	63
Fierce EZ (Scout + Perpetuo + Select Max + Induce + N-Pak AMS Liquid[c])	6.0 fl. oz. + (32.0 fl. oz. + 6 fl. oz. + 9.0 fl. oz. + 0.25% v/v + 3.53 qt.)	PRE + (POST)	98	78	98	38
Fierce MTZ SC + (Scout + Perpetuo + Select Max + Induce + N-Pak AMS Liquid)	16.0 fl. oz. + (32.0 fl. oz. + 6 fl. oz. + 9.0 fl. oz. + 0.25% v/v + 3.53 qt.)	PRE + (POST)	98	80	99	57
Zidua SC + Liberty 280 SL + N-Pak AMS Liquid	3.0 fl. oz. + 32.0 fl. oz. + 3.53 qt.	POST	93	50	95	27
Zidua SC + Liberty 280 SL + N-Pak AMS Liquid + Poly Tex	3.0 f.l oz. + 32.0 fl. oz. + 3.53 qt. + 1.0% v/v	POST	93	40	88	23
LSD (P=0.05)			3	9	9	29

[a]Xtendimax wVGT = Xtendimax With Vaporgrip Technology.
[b]v/v = Volume of product per volume tank mix.
[c]N-Pak AMS liquid = ammonium sulfate.
[d]Setfa = giant foxtail, Abuth = velvetleaf, Amata = common waterhemp, Ipohe = ivyleaf morningglory



Accelerating Breeding in Maize: Haploid × Haploid Crosses After Genomic Selection

Ursula K. Frei—research scientist, Department of Agronomy

Doubled haploid (DH) technology reduces the time to generate completely homozygous lines in maize to just two generations. As part of the OREI COOP project, a two-generation rapid cycling breeding scheme, based on crosses between marker-selected haploid plants in the first generation and haploid induction in the second, was proposed to further speed up the breeding cycle.

The scheme exploits the ability of haploids with the trait of spontaneous haploid genome doubling (SHGD) in their genetic background, to produce viable pollen and fertile ears in high percentages. In combination with genomic selection, haploids with favorable alleles can be directly crossed to generate F1 seed for induction crosses in the off-season (Figure 1).

An initial experiment was performed to show that haploid × haploid crosses are possible, and yield sufficient seed for subsequent induction of generated F1.

Materials and Methods

Haploids generated in 30 different families generated in the background of the BS39 population with the added trait for SHGD, were seeded in three delayed sets. While one set was strictly self-pollinated, as many cross-pollinations as possible were attempted within and between the other two sets, using each haploid only once as a male. At harvest, individual ears were harvested, shelled, and the seed set determined.

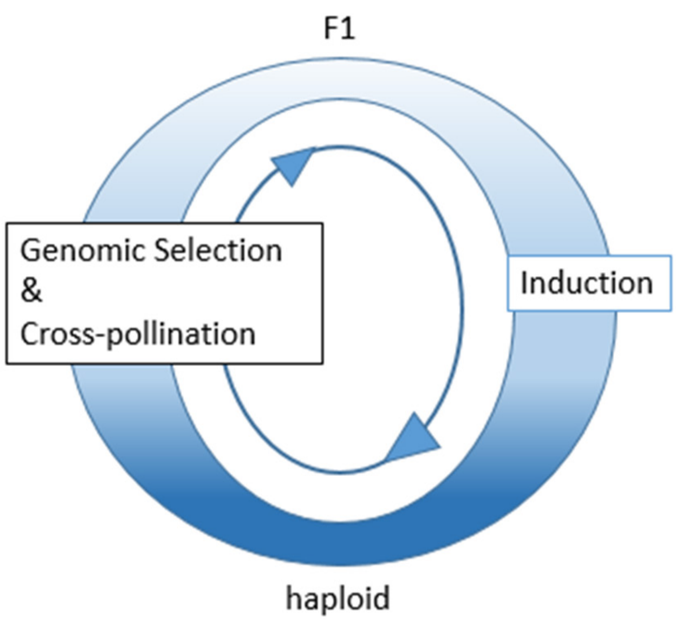


Figure 1. Rapid cycle breeding scheme using haploid × haploid crosses.

Results and Discussion

On average, 19.6 plants per donor family, or ca. 590 haploids total were present in each set. About 39% of the haploid plants showed restored fertility and were used in self- or cross-pollinations.

Seed set in cross-pollinations was at 65% of the attempted pollinations, which was higher than strict self-pollinations (54%), since wide anther-silking intervals in the haploids often are a restricting factor in self-pollination, but not for the cross-pollinations. Depending on the number of seed produced per ear, the harvested ears were divided in two groups (1: 1-19 seeds, 2: 20+ seeds).

A larger percentage of the ears generated in crosses fell into the groups with less than 20 seed per ear (73.1% versus 56.8%), whereas the self-pollinated ears dominated in the group with higher seed set (Figure 2). In the cross-pollinations, any haploid plant showing silk was pollinated, independent if it had restored male fertility or not. It was obvious plants that had restored male fertility also showed increased female fertility and resulted in better seed set. This might be one of the reasons why self-pollinations yielded more seed, as these represent haploids with both male and female fertility restored. F1 seed amounts of 20 seeds and more are sufficient to generate at least 100 haploids for the next cycle.

The scoring for the SHGD trait focuses on the levels of restored male fertility, as this is the major bottleneck in DH production, while female fertility restoration usually is sufficient for self-pollinations. With the goal to use haploid × haploid crosses for rapid cycling, female fertility restoration and sufficient seed set becomes more important. The F1 generated in 2022 between haploids serve as donor populations for inductions during the winter, for another cycle of haploid × haploid crosses in the coming season, and a more thorough evaluation of the female side of the equation.

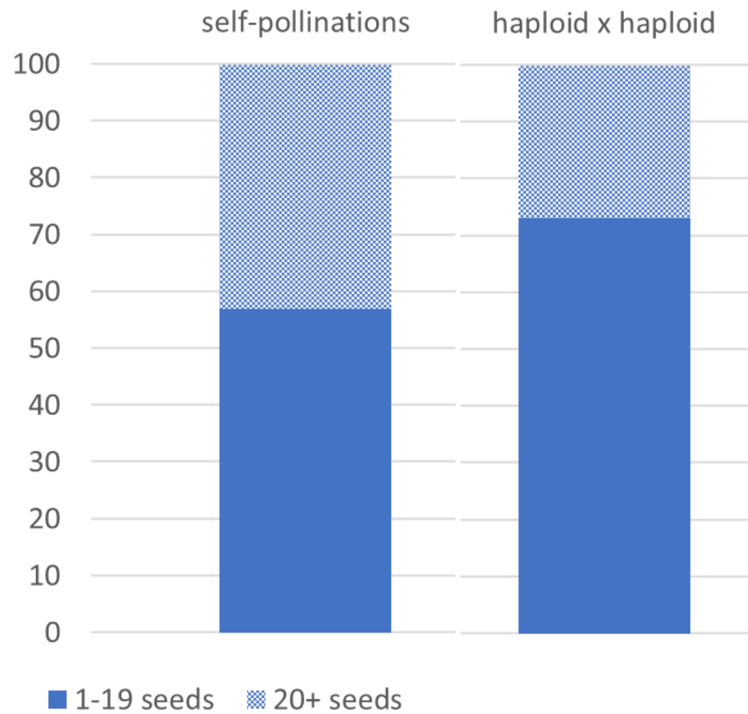


Figure 2. Percent ears with seed sets below or above 20 seeds in self- and cross-pollinations of haploids.

Acknowledgements

This research is funded by USDA NIFA Project 2020-51300-32180.

Carcass Management Research at LBREC

Brett Ramirez—assistant professor, Department of Agricultural and Biosystems Engineering

Daniel Andersen—associate professor, Department of Agricultural and Biosystems Engineering

Sara Weyer—former graduate research assistant, Department of Agricultural and Biosystems Engineering

A foreign animal disease outbreak or other catastrophic event impacting the swine industry may require the need to depopulate facilities, resulting in large numbers of mortalities. If these mass mortalities are not managed properly, there can be negative economic consequences and challenges with biosecurity. Current methods to dispose of swine mortalities include composting bins for routine carcass disposal, composting windrows, shallow burial, landfill disposal, rendering for non-infected carcasses, and incineration.

However, these existing methods pose a risk to biosecurity if the animals were diseased with a highly pathogenic virus. Removing carcasses from an infected facility poses an immediate threat to biosecurity because of the exposure of the pathogen to the environment via air, water, soil, vegetation, or fomites (i.e., people, vehicles, and carcass handling equipment); therefore, more biosecure methods of mortality management strategies are needed for swine. The goals of this research (Figure 1) were to create a novel mobile test facility replicating a typical swine finishing barn, validate the facility performance, and execute tests for in-barn carcass management strategies to characterize carcass response.

Approach

A small-scale, mobile swine confinement laboratory was designed and built to mitigate the challenges faced in a full-scale barn. The mobility of the laboratory enables it to travel to swine farms to obtain fresh animal specimens, which

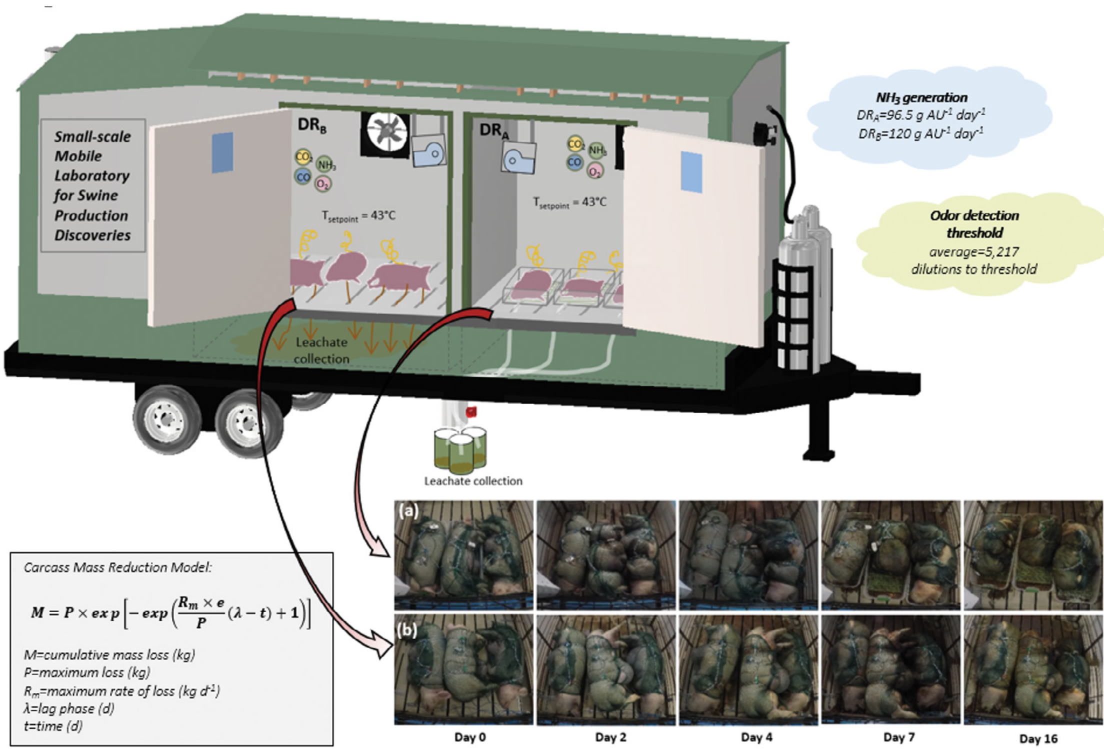


Figure 1. Graphical abstract depicting the mobile small-scale facility with two discovery rooms and an overview of the carcass composition and thermal research.

allows the experiments and data collected to be more representative of an in-barn application. The model facility, built on a flat-bed trailer, has two identical, fully instrumented rooms (L × W × H) of 2.24 × 2.29 × 2.05 m (88.0 × 90.0 × 80.5 in.) with a 0.46 m (18 in.) shallow pit, replicating typical swine finishing rooms. Walls were composed of typical wood-frame construction with interior paneling and metal clad on the exterior. Instrumentation allows the environment and air quality of the rooms, along with other parameters, to be controlled and monitored. The rear portion of the trailer includes an instrumentation room to house necessary computers, controllers, and associated equipment. Commissioning of components and verifying function of equipment were performed, which included quantifying infiltration and performing a thermal analysis for each room.

Carcasses were desiccated by subjection to heat at a room air temperature of 43°C (110°F) for 16 days. Three carcasses (average = 82 kg, SE = 1.27 kg) were elevated over individual leachate collection systems in Discovery Room (DR) A, thereby removing leachate from the room. Three carcasses in DRB were placed on concrete slats with cumulative leachate collection in the pit below. Environmental data were collected for DR, outdoor, and slat temperatures; and CO_2, CO, O_2, and NH_3 gas concentrations. Carcasses were characterized by rectal and shoulder temperature monitoring and daily weighing of carcasses and leachate in DRA. The air exchange rate for this unventilated system was quantified based on wind and thermal-driven infiltration. Room environments were compared for thermal performance and gas levels.

Key Findings

A mobile, general-purpose laboratory replicating a typical swine production setting equipped with full instrumentation was designed and constructed for small-scale in-barn experimentation. The laboratory is built in style of a typical swine finishing building but allows more control than a full-scale barn and requires less labor and other monetary inputs. The mobility of the laboratory makes it ideal for testing in remote locations and isolation if necessary. Many useful features such as cameras, environmental monitoring, and remote ventilation control make the laboratory a preferred space to carry out a variety of studies on a small-scale. Verification of laboratory function and quantification of parameters, such as infiltration, have been documented and recorded.

Carcass temperatures were compared, and data suggested no significant impact of flooring material on internal carcass temperature. Gompertz and logistic models were fit to leachate production data and carcass mass reduction data (Figure 2). Ammonia generation rates were found to have a peak production rate of 96.5 g AU-1 day-1 (15.8 g animal-1 day-1) in DRA and 120 g AU-1 day-1 (19.7 g animal-1 day-1) in DRB. Over the study, the generation of NH3 in DRB (360 g) was nearly twice that of DRA (182 g) due to leachate removal.

Additionally, knowledge of carcass decomposition rates and internal carcass temperature will help gauge when mortalities can be removed from group-housed confinements to continue decomposing using an established carcass management method. This research will assist the swine industry by providing more biosecure in-barn alternatives to carcass management than existing methods in the event of a disease outbreak or other mass mortality event. This work will advance the existing knowledge of in-barn strategies for swine and, if adopted, will aid in reducing potential disease spread due to poor carcass management.

Acknowledgements

This research was funded in part by a grant from the Iowa Pork Producers Association (#19–223IPPA). This work is a product of the Iowa Agriculture and Home Economics Experiment Station, Ames, Iowa. Project No. IOW04100 are sponsored by Hatch Act and State of Iowa funds. The content of this article is, however, solely the responsibility of the authors and does not represent the official views of the USDA.

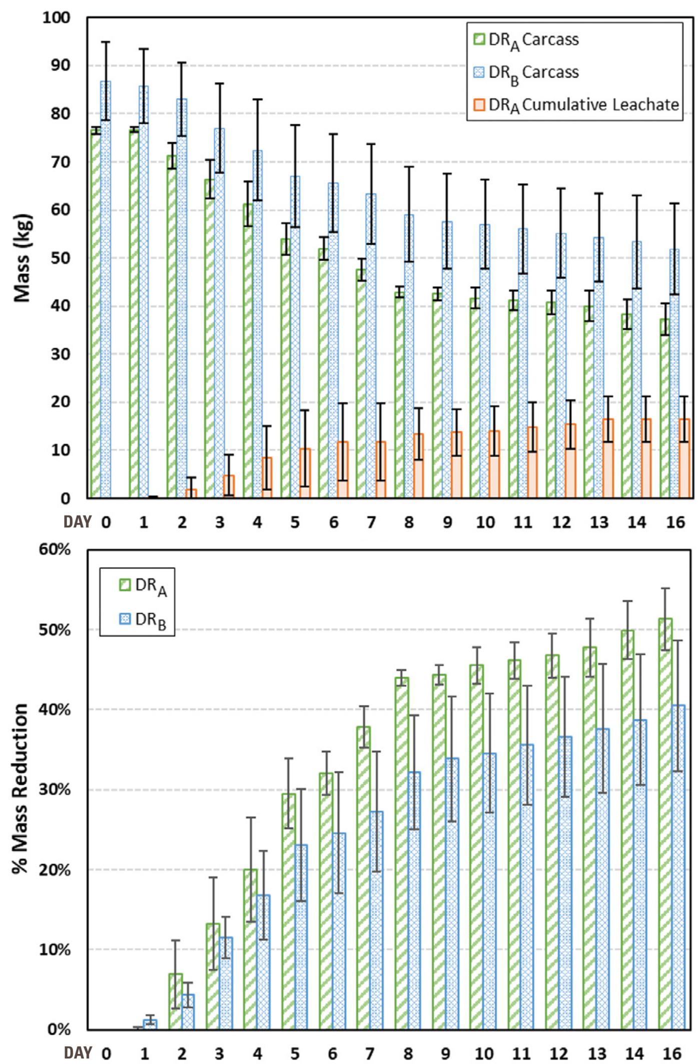


Figure 2. Daily carcass weights and leachate weights by room with standard deviation uncertainty (top); daily average carcass percent mass reduction with standard deviation uncertainty (bottom).Remaining leachate in collection bins was averaged and added to daily leachate totals. Carcass and leachate were not weighed on day 15 of the trial.

Understanding Genotype, Crop Sequence, Plant Density, N-Fertilizer Rate, Effects on Corn Stover Quantity and Quality

Alejo Ruiz—research assistant, Department of Agronomy

Jode Edwards—affiliate associate professor, Department of Agronomy

Sotirios Archontoulis—associate professor, Department of Agronomy

Although corn stover has little direct economic value for most farmers, it is critical to ecosystem performance and sustainability. Studies describing responses in maize stover traits relevant to the system performance and sustainability are limited. The objective of this study was to determine and dissect plant density, N-fertilizer, hybrids, and crop rotation impacts on maize grain yield, stover quantity, and stover C:N ratio.

Materials and Methods

Four rainfed field experiments were conducted at the Boone researchfarm in two contiguous fields during 2021 and 2022. In both years, one field was on continuous corn, and the other was in a corn-soybean rotation, resulting in four crop sequence-year combinations. Three commercial genotypes were evaluated across N-fertilizer rates (0, 130, and 300 lb. N acre^{-1}) and plant densities (15,500, 31,000, and 46,500 plants acre^{-1}), totaling 27 treatments in each field. The planting dates were mid-May in both seasons. The grain yield and stover ratio were estimated at physiological maturity by destructively sampling plants from each plot. After grounding the samples, the stover N content was determined using a CHNS Elemental Analyzer (Elementar Americas). Grain yield is reported at 15 g. kg.$^{-1}$ moisture, while stover at 0 g. kg.$^{-1}$ moisture.

Results

Corn grain yield across experiments and treatments ranged from 26 to 270 bushels acre-1, stover amount from 1.0 to 5.7 ton acre^{-1}, and stover C:N ratio from 34 to 125. The N-fertilizer rate explained the largest proportion of the trait variation. The grain yield difference between the lowest and largest N rate was 79 bushels acre^{-1}, the stover difference 1.0 ton acre^{-1}, and 36 units of CN ratio. Plant density was the second largest source of variation across traits. The grain yield difference between plant densities was 25 bushels acre^{-1}, the stover difference 0.6 ton acre^{-1}, and five units of CN ratio. Genotype explained less than 1% of trait variations, being less than eight bushels acre^{-1}, the grain yield difference across genotypes, 0.1 ton acre^{-1} in stover, and two units of CN ratio. These results show the impact of N-fertilizer not only in corn grain yield, but also in the amount and quality of the stover left in the field.

Table 1. Minimum, Maximum, and Genotype, N-rate, Plant density, and Crop sequence effect on grain yield, stover amount, and stover CN ratio.

Main effects		Grain yield	Stover amount	Stover CN
		Bushels acre^{-1}	Ton acre^{-1}	
Minimum		26	1.0	34
Maximum		270	5.7	125
Genotype	Hybrid 1	167	3.3	73
	Hybrid 2	158	3.4	75
	Hybrid 3	161	3.3	73
N rate (lb. N acre^{-1})	0	111	2.7	92
	130	185	3.6	73
	300	190	3.7	56
Plant density (plants acre^{-1})	15 500	151	2.9	71
	31 000	176	3.4	73
	46 500	160	3.6	76
Crop sequence	Maize-maize	149	3.1	76
	Soybean-maize	175	3.5	71
Year	2021	156	3.2	77
	2022	169	3.4	70

Acknowledgments

We want to thank Mike Fiscus, Nathan Meyers, and the farm staff at Iowa State University Boone Research Farm for conducting these field operations.

Soybean Breeding Program Update

Asheesh Singh—professor, Department of Agronomy

Brian Scott—agricultural specialist, Department of Agronomy

Jennifer Hicks—research scientist, Department of Agronomy

Ryan Dunn—agricultural specialist, Department of Agronomy

David Zimmerman—research associate, Department of Agronomy

The Iowa State University soybean breeding program started in 2014. The focus of this program is to develop soybean varieties for Iowa and Midwest farmers. Additionally, researchers are active in scientific discovery and tool development related to breeding and crop production. The group consists of graduate and undergraduate research students who are going to become the next generation scientists and breeders capable in agriculture, engineering, and data sciences related topics. The work this group does at farms is critical for their success, as this generates valuable research and breeding data. Since inception, this group has commercialized four soybean varieties that are suitable for food grade market, which can provide a higher premium to farmers. The group is very appreciative of the support received from farm staff and managers. In 2022, there were over 40,000 variety plots on various research farms across Iowa. These research plots supported several graduate students and fellows.

Group mission. To educate the next generation of breeders in agriculture, engineering, and data science to develop tools and technologies that advance science and empower farmers to increase profitability and sustainability.

Group research goals. To improve agricultural production and positively impact farmers and the agriculture industry through the development of new products (cultivars, germplasm, methods, tools), gene discovery, and research insights on pertinent topics. Specifically, breeding non-GM and food grade soybean.

Update. The group is preparing to commercialize one new variety in 2022-2023, and foundation seed production was completed in fall 2022. This new variety combines good seed yield with high protein, higher sucrose, low raffinose, low stachyose, and larger seed size. It has a maturity rating of mid-MGII and will meet the need of companies and farmers interested in growing a food grade soybean, due to its clear hilum color along with a combination of yield, protein, carbohydrate and seed size traits.

Earlier, three varieties IAS19C3, IAS25C1 and IAS31C1 were commercialized. IAS19C3 is a high yield and high protein line with yellow hilum, while IAS25C1 and IAS31C1 are high yielding yellow hilum varieties with soybean aphid tolerance. A continuous output of new varieties catering to the need of soybean farmers is expected. Twenty-two research papers were published in the past two years on soybean, helping advance digital and precision agriculture, disease and stress protection, yield enhancement and better methods, tools, and breeding approaches. Ten graduate students have completed their degree, and are pursuing various jobs in public or private sector, or continuing their education

Acknowledgements

We thank the funding support received from the Iowa Soybean Association, United Soybean Board, North Central Soybean Research Program, USDA-NIFA, USDA Hatch, National Science Foundation, and Iowa State University (R F Baker Center, Iowa Soybean Research Center, and Plant Sciences Institute).

Corncob-Amended Woodchip Bioreactors Showed Improved Nitrate Removals in a Pilot-scale Study

Michelle Soupir—professor, Department of Agricultural and Biosystems Engineering

Ji Yeow Law—engineer, Department of Agricultural and Biosystems Engineering

Woodchip denitrification bioreactors are an effective practice to reduce nitrate-nitrogen export from tile drainage. However, there are challenges for wide-scale implementation due to limited woodchip supply and rising woodchip costs. Corncob, a locally available carbon source, was investigated as a potential alternative. Additionally, there are opportunities to improve nitrate removal using corncobs, which has been demonstrated in lab studies. This work aimed to evaluate nitrate removal using pilot-scale corncob-amended woodchip bioreactors.

Materials and Methods

Six of the nine pilot-scale woodchip (WC) bioreactors installed at the Agricultural Engineering/Agronomy (AEA) Research Farm were amended with corncobs (CC) in 2018 (Figure 1). After modification, three bioreactors contained 25% CC + 75% WC, three bioreactors contained 75% CC + 25% WC, and three unamended bioreactors contained 100% WC. The flow conditions were adjusted to achieve treatment times of 2-, 8-, and 16-hours. Water samples were collected at each bioreactor inlet and outlet, and were analyzed for nitrate concentrations to calculate the percentages of nitrate removed.

Figure 1. Pilot-scale bioreactors were amended with corncobs in 2018.

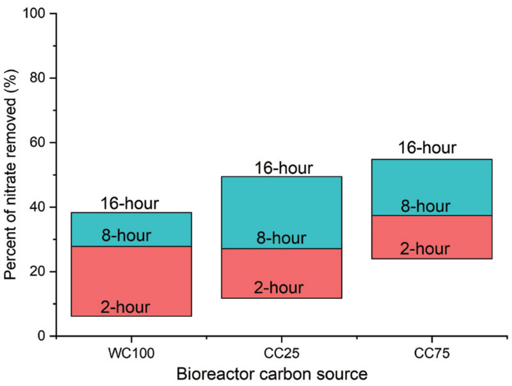


Figure 2. Percentage range of nitrate removed using 100% woodchip bioreactors (WC100), 25% CC + 75% WC bioreactors (CC25), and 75% CC + 25% WC bioreactors (CC75) at different treatment times.

Results and Discussion

2019-2022 data showed that bioreactors with larger amounts of CC can remove higher percentages of nitrate. Additionally, the percentages of nitrate removed were higher at longer treatment times (at the expense of lower treatable daily flow volumes). In this study, the bioreactors containing only WC removed 6-38% (varied depending on treatment time) of the nitrate (Figure 2). When 25% of CC was added, the bioreactors can remove 12-49% of the nitrate. Finally, the bioreactors containing 75% CC removed 38-55% of the nitrate.

Acknowledgments

This research was supported by the Iowa Nutrient Research Center.

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