Welcome to the 10th annual Crop Production Clinics. It is my sincere hope that the unbiased, research-based information you have come to expect will again this year help improve the success of your farm or business.

The Clinics have a long history as a part of Nebraska Extension beginning in 1974 as the Crop Protection Clinics (1974 to 2008). In 2009 the Clinics were re-named the 'Crop Production Clinics' when content was expanded to include Soil Fertility, Irrigation, and Cropping Systems in addition to Pesticide Safety; Agribusiness Marketing and Management; Insect, Plant Disease, and Weed Management.

The *2018 Proceedings* contains articles summarizing information presented at all the Clinic locations. It is intended to be both a workbook for you to use during the clinic as well as a reference after the clinic. The proceedings are also available electronically at www.agronomy.unl.edu/2018-CPC-Proceedings

This year we made a few changes to the Clinic locations and content with the intent to provide regionally relevant information. Our hope is these changes increase our ability to provide high-impact training for Nebraska's producers and agricultural professionals. We are continually trying to improve the program. If you have any comments or suggestions about how continue to develop the Clinics, please let us know.

2018 Crop Production Clinics

January 10, Gering Civic Center, Gering
January 11, Sandhills Convention Center, North Platte
January 15-16, Lifelong Learning Center, Northeast Community College, Norfolk
January 18, Embassy Suites, Lincoln

Sincerely,

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University of Nebraska–Lincoln Extension

2017 Crop Production Clinics

Impact Report

Impact on Nebraska agriculture

<u>1,558</u> total participants; 9 locations

- Over 90% of respondents attended past CPC's
- 24% identify as producers
- 26% identify as being involved in agriculture sales
- 17% identify as crop consultants
- 23% identify as custom applicators

<u>6.6 million</u> total acres influenced

- 3.4 million acres of corn
- 2.2 million acres of soybeans
- 666,667 acres of wheat
- 220,000 acres of alfalfa
- 133,333acres of sorghum/millet

<u>2.6 million</u> acres of irrigated cropland influenced

92% found the *Crop Production Clinics Proceedings* valuable to their operation

87% felt that the clinic would increase the profitability of their operation

This increase in value was estimated at $3.91 per acre

Total estimated value from the clinic was over $26

What attendees said

"Very good information. Relative topics."

"Professional and knowledgable presenters."

"Well organized."

"Keeps me in tune with cutting edge information for the coming crop year."

"The speakers explained complicated things in a simple way."

"Opportunity to connect with the university and others in the ag industry."

For more information and to download a copy of the *Crop Production Clincs Proceedings*, visit agronomy.unl.edu/cpc

Nebraska Lincoln EXTENSION

Crop Production Clinics

Practical, Profitable, Environmentally Sound

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BASF The Chemical Company

SureFire Ag Systems

2018 Crop Production Clinics

Registration

On-site registration: Begins at 8:00 a.m.

Cost:

Pre-registration: $80.00

On-site registration: $95.00

Included with Registration:

- Lunch and refreshments
- 2018 Guide for Weed, Disease and Insect Management
- 2018 CPC Proceedings
- Pesticide License Recertification
- CCA Credits

Make checks payable to the: *University of Nebraska-Lincoln*

Pesticide Applicator Recertification

Commercial/Noncommercial:

Applicators may renew their licenses in the categories:

- Ag Plant (01)
- Demonstration/Research (D/R)

To recertify you must attend any 3 sessions in the morning **AND** all presentations in the Pest Management Section in the afternoon, **AND** complete the NDA license renewal form at the end of the day.

Private:

To recertify you must attend 3 sessions in the morning **AND** all presentations in the Pest Management Section in the afternoon, **AND** complete the NDA license renewal form at the end of the day.

Dicamba Applicator Training:

To receive Dicamba Applicator certification you must attend all presentations in the Pest Management Section in the afternoon **AND** complete NDA paperwork at the end of the day.

Certified Crop Advisors

Earn a maximum of 6.0 CEUs in a given day. The following credits are available in today's program:

- 6.0 CEU in Pest Management
- 1.0 CEU in Nutrient Management
- 2.0 CEU in Soil & Water Management
- 1.5 CEU in Crop Management
- 1.5 CEU in Professional Development

To receive CCA credit: Please print and sign your name and provide your CCA number for each session you attend. Your certification number must be provided to receive credit.

2018 Crop Production Clinic
GERING

Gering Civic Center,
1050 M Street
January 10, 2018

<u>Pest Management & Pesticide Safety</u>

8:00 – 8:45 Registration/Check in

8:45 Welcome

9:00 – 9:50 Disease Management
Wheat Disease Update: Wheat Streak Mosaic and Stripe Rust (p.27)
Specialty Crops Disease Update - 2018 (p.29)
Corn Disease Update (p.31)

9:50 – 10:00 Break

10:00 – 10:50 Weed Management
Herbicide-Resistant Kochia, Palmer, and Waterhemp in the Panhandle: Distribution and Management (p.56)

10:50 – 11:00 Break

11:00 – 11:50 Insect Management
Wheat Insect Pest Update (p.17)

11:50 – 12:35 Lunch

12:35 – 1:25 Pesticide & Environmental Safety
Applying Pesticides Safely (p.25)

1:25 – 1:35 Break

1:35 – 2:25 Weed and Disease Management
1:35 – 2:05 Managing Pesticide Applications for Me and the Environment (p.58)
2:05 – 2:25 What's New in Plant Pathology (p.38)

2:25 – 2:35 Break

2:35 – 3:25 Disease and Insect Management
2:35 – 2:55 Fungicides are for Fungi (p.40)
2:55 – 3:25 Panhandle Insects in 2017

3:25 Program Evaluation & NDA Paperwork

<u>Crop, Econ, Soil & Water Management</u>

8:00 – 8:45 Registration/Check in

8:45 Welcome

9:00 – 9:50 Soils & Agribusiness
9:00 – 9:25 Crop Residue and High-Carbon Char: Potential Soil Conservation Tools (p.42)
9:25 – 9:50 Farm Program Payments and Projections for Nebraska (p.1)

9:50 – 10:00 Break

10:00 – 10:50 Crop Production & Water Management
10:00 – 10:25 Winter Wheat: Planting Dates, Populations and Gibberellic Acid
10:25 – 10:50 North Platte River Surface Irrigation Projects and Power Generation (p.53)

10:50 – 11:00 Break

11:00 – 11:50 Soil Fertility
Improved Use Efficiency of Applied Organic Nitrogen (p.46)
Feasibility of Sensor Based Nitrogen Fertigation Management in Corn (p.50)

11:50 – 12:35 Lunch

12:35 – 1:25 Agribusiness Management
Trends in Nebraska Land Values and Cash Rents 2017-2018 (p.3)
Cash Flow Budgeting for Farms & Ranches (p.5)

1:25 – 1:35 Break

1:35 – 2:25 Water Management
Irrigation Scheduling and Crop Water Stress Monitoring Using Sensors

2:25 – 2:35 Break

2:35 – 3:25 Crop Production
When to Replant Sugarbeets: The Relationship Between Population, Yield, and Replant Timing (p.7)
Variety Trial Results in the Panhandle: Dryland Soybean, Dry Bean, Forage Sorghum, Grain Sorghum and Irrigated Forage Sorghum

3:25 Program Evaluation

2018 Crop Production Clinic
North Platte
Sandhills Convention Center
2102 S. Jeffers
January 11, 2018

Pest Management & Pesticide Safety

8:00 – 8:45 Registration/Check in

8:45 Welcome

9:00 – 9:50 Disease Management
Corn Disease Update (p.31)
Wheat Disease Update: Wheat Streak Mosaic and Stripe Rust (p.27)
Root and Soilborne Diseases Update (p.36)

9:50 – 10:00 Break

10:00 – 10:50 Weed Management
Managing Pesticide Applications for Me and the Environment (p.58)

10:50 – 11:00 Break

11:00 – 11:50 Insect Management
Corn Insect Pest Updates: Western Corn Rootworm & Western Bean Cutworm (p.18 &19)

11:50 – 12:35 Lunch

12:35 – 1:25 Pesticide & Environmental Safety
Applying Pesticides Safely (p.25)

1:25 – 1:35 Break

1:35 – 2:25 Weed and Disease Management
1:35 – 2:05 The Good, the Bad and the Ugly when Spraying the New Phenoxy Herbicides Formulations in Xtend and Enlist Soybeans (p.62)
2:05 – 2:25 What's New in Plant Pathology (p.38)

2:25 – 2:35 Break

2:35 – 3:25 Disease and Insect Management
2:35 – 2:55 Fungicides are for Fungi (p.40)
2:55 – 3:25 What's New in Entomology: West Central Nebraska

3:25 Program Evaluation & NDA Paperwork

Crop, Econ, Soil & Water Management

8:00 – 8:45 Registration/Check in

8:45 Welcome

9:00 – 9:50 Soils & Agribusiness
9:00 – 9:25 Crop Residue and High-Carbon Char: Potential Soil Conservation Tools (p.42)
9:25 – 9:50 Farm Program Payments and Projections for Nebraska (p.1)

9:50 – 10:00 Break

10:00 – 10:50 Crop Production & Water Management
10:00 – 10:25 Is Soybean Yield Limited by Nitrogen Supply? (p.9)
10:25 – 10:50 Soybean Irrigation Strategies for Western Nebraska

10:50 – 11:00 Break

11:00 – 11:50 Soil Fertility
Improved Use Efficiency of Applied Organic Nitrogen (p.46)
Feasibility of Sensor Based Nitrogen Fertigation Management in Corn (p.50)

11:50 – 12:35 Lunch

12:35 – 1:25 Agribusiness Management
Trends in Nebraska Land Values and Cash Rents 2017-2018 (p.3)
Cash Flow Budgeting for Farms & Ranches (p.5)

1:25 – 1:35 Break

1:35 – 2:25 Water Management
TAPS - Farm Management Competition Results

2:25 – 2:35 Break

2:35 – 3:25 Crop Production
Winter Wheat: Planting Dates, Populations, and Gibberellic Acid
Field and Season Specific N Rate Recommendation for Corn Using Maize-N Program (p.12)

3:25 Program Evaluation

2018 Crop Production Clinic
NORFOLK

Lifelong Learning Center, NECC
601 East Benjamin
January 15, 2018
January 16, 2018

Pest Management & Pesticide Safety

8:00 – 8:45 **Registration/Check in**

8:45 **Welcome**

9:00 – 9:50 **Disease Management**
Corn Disease Update (p.31)
Soybean Disease Update (p.33)

9:50 – 10:00 **Break**

10:00 – 10:50 **Weed Management**
The Rise of Multiple-Resistance in Nebraska's Weeds and Effects of Dicamba Micro-Rates on Sensitive Crops (p.60)

10:50 – 11:00 **Break**

11:00 – 11:50 **Insect Management**
Corn Insect Update (p.21-24)

11:50 – 12:35 **Lunch**

12:35 – 1:25 **Pesticide & Environmental Safety**
Applying Pesticides Safely (p.25)

1:25 – 1:35 **Break**

1:35 – 2:25 **Weed and Disease Management**
1:35 – 2:05 The Good, the Bad and the Ugly when Spraying the New Phenoxy Herbicides Formulations in Xtend and Enlist Soybeans (p.62)
2:05 – 2:25 What's New in Plant Pathology (p.38)

2:25 – 2:35 **Break**

2:35 – 3:25 **Disease and Insect Management**
2:35 – 2:55 Fungicides are for Fungi (p.40)
2:55 – 3:25 New Insect Pest Issues in Northeast Nebraska (p.20)

3:25 **Program Evaluation & NDA Paperwork**

Crop, Econ, Soil & Water Management

8:00 – 8:45 **Registration/Check in**

8:45 **Welcome**

9:00 – 9:50 **Soils & Agribusiness**
9:00 – 9:25 Crop Residue and High-Carbon Char: Potential Soil Conservation Tools (p.42)
9:25 – 9:50 Farm Program Payments and Projections for Nebraska (p.1)

9:50 – 10:00 **Break**

10:00 – 10:50 **Crop Production & Water Management**
10:00 – 10:25 Is Soybean Yield Limited by Nitrogen Supply? (p.9)
10:25 – 10:50 Economics of Variable Frequency Drives for Irrigation Pumps (p.54)

10:50 – 11:00 **Break**

11:00 – 11:50 **Soil Fertility**
Improved Use Efficiency of Applied Organic Nitrogen (p.46)
Feasibility of Sensor Based Nitrogen Fertigation Management in Corn (p.50)

11:50 – 12:35 **Lunch**

12:35 – 1:25 **Agribusiness Management)**
Trends in Nebraska Land Values and Cash Rents 2017-2018 (p.3)
Cash Flow Budgeting for Farms and Ranches (p.5)

1:25 – 1:35 **Break**

1:35 – 2:25 **Water Management**
Advances in Irrigation-Impacts on Water Resources Management

2:25 – 2:35 **Break**

2:35 – 3:25 **Crop Production**
Field and Season Specific N Rate Recommendation for Corn Using Maize-N Program (p.12)
Integrating Cover Crops into a Corn and Soybean Cropping System (p.14)

3:25 **Program Evaluation**

2018 Crop Production Clinic
LINCOLN
Embassy Suites
1040 P Street
January 18, 2018

Management & Pesticide Safety

8:00 – 8:45 **Registration/Check in**

8:45 **Welcome**

9:00 - 9:50 **Disease Management**
Soybean Disease Update (p.33)
Wheat Disease Update: Wheat Streak Mosaic and Stripe Rust (p.27)
Corn Disease Update (p.31)

9:50 – 10:00 **Break**

10:00 – 10:50 **Weed Management**
Dicamba Off Target Injury Issues in Nebraska Soybean (p.65)

10:50 – 11:00 **Break**

11:00 – 11:50 **Insect Management**
Corn Insect Update: Japanese Beetle in Corn and Soybeans; Large Populations of Painted Lady Butterflies; Insects in Cover Crops (p.21-24)

11:50 – 12:35 **Lunch**

12:35 – 1:25 **Pesticide & Environmental Safety**
Applying Pesticides Safely (p.25)

1:25 – 1:35 **Break**

1:35 – 2:25 **Weed and Disease Management**
1:35 – 2:05 The Good, the Bad and the Ugly when Spraying the New Phenoxy Herbicides Formulations in Xtend and Enlist Soybeans (p.62)
2:05 – 2:25 What's New in Plant Pathology (p.38)

2:25 – 2:35 **Break**

2:35 – 3:25 **Disease and Insect Management**
2:35 – 2:55 Fungicides are for Fungi (p.40)
2:55 – 3:25 Emerging Crop Insect Issues

3:25 **Program Evaluation & NDA Paperwork**

Crop, Econ, Soil & Water Management

8:00 – 8:45 **Registration/Check in**

8:45 **Welcome**

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11:50 –12:35 **Lunch**

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Trends in Nebraska Land Values and Cash Rents 2017-2018 (p.3)
Cash Flow Budgeting for Farms & Ranches (p.5)

1:25 – 1:35 **Break**

1:35 – 2:25 **Water Management**
Advances in Irrigation-Impacts on Water Resources Management

2:25 – 2:35 **Break**

2:35 – 3:25 **Crop Production**
Field and Season Specific N Rate Recommendation for Corn Using Maize-N Program (p.12)
Integrating Cover Crops into a Corn and Soybean Cropping System (p.14)

3:25 **Program Evaluation**

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Farm Program Payments and Projections for Nebraska

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Extension Associate Professor and Policy Specialist

Price Loss Coverage (PLC) and Agriculture Risk Coverage (ARC) program payments under the 2014 Farm Bill have been substantial in Nebraska, adding more than $600 million to cash flows for producers this past October for the third year in a row. However, this could be the last year of such large payments, as early estimates for 2017 crop payments to be paid in the fall of 2018 drop to around $200 million and 2018 crop payments in 2019 fall to less than $50 million.

Farm program payments and estimates start with national marketing year average prices given in Table 1 for the primary Nebraska crops for the 2014-2018 crop marketing years covered by the 2014 Farm Bill.

Table 1. Price Projections*

Commodity	Reference Price ($/bushel)	Prices ($/bushel)				
		2014	2015	2016	2017	2018
Corn	**3.70**	**3.70**	**3.61**	**3.36**	**3.20**	**3.59**
Grain Sorghum	**3.95**	**4.03**	**3.31**	**2.79**	**2.90**	**3.38**
Soybeans	**8.40**	**10.10**	**8.95**	**9.47**	**9.20**	**9.53**
Wheat	**5.50**	**5.99**	**4.89**	**3.89**	**4.60**	**4.84**

** Final price estimates for 2014-2016 from USDA-NASS. Price projections for 2017 from USDA-WAOB and USDA-FSA as of October 2017. Price projections for 2018 from CBO as of June 2017.*

Sources: USDA-FSA, USDA-NASS, USDA-OCE, USDA-WAOB, and CBO.

Payment and Projections

PLC payment rates are directly tied to the difference between the legislated reference price and the national marketing year average price. As prices have fallen, PLC payment rates have substantially increased. Table 2 presents average PLC payment rates or projections per base acre for the 2014-2018 crop years, based on average program yield levels across the state.

Table 2. Average PLC Payment Rates in Nebraska*

Commodity	Average PLC Payment Yield (bushels/acre)	Average PLC Payment Rates per Base Acre ($/base acre)				
		2014	2015	2016	2017	2018
Corn	**150**	**0.00**	**11.47**	**43.31**	**63.70**	**14.01**
Grain Sorghum	**77**	**0.00**	**41.95**	**76.04**	**68.83**	**37.36**
Soybeans	**45**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Wheat	**41**	**0.00**	**21.19**	**55.93**	**31.26**	**22.93**

** PLC payments and payment projections based on weighted average PLC payment yields in Nebraska. Payments based on prices for 2014-2016 from USDA-NASS, price projections for 2017 from USDA-WAOB and USDA-FSA as of October 2017 and price projections for 2018 from CBO as of June 2017.*

Sources: USDA-FSA, USDA-NASS, USDA-OCE, USDA-WAOB, and CBO.

While the PLC program started small, it is becoming more significant over the life of the 2014 Farm Bill. Conversely, the ARC program started off with substantial payments, but is expected to shrink quickly through 2018. Payments in the ARC-CO (county-level) program are tied to revenue (price times yield) results for the crop year compared to a guarantee equal to 86% of a benchmark revenue based on the five-year Olympic average price and yield. ARC-IC (for individual farm-level coverage) is calculated similarly, but on farm-level yield averages and results.

As Table 3 illustrates, average ARC-CO payment rates per base acre were large in the first years of the 2014 Farm Bill, but are falling as lower prices work into the average in the benchmark and lower guarantees translate into lower projected payments even as prices do not substantially rebound higher.

Table 3. Average ARC-CO Payment Rates in Nebraska*

Commodity	County/Practice Combinations	Average ARC-CO Payment Rates per Base Acre ($/base acre)				
		2014	2015	2016	2017	2018
Corn	131	53.31	52.36	52.89	12.62	0.00
Grain Sorghum	103	18.44	21.54	29.25	8.01	3.43
Soybeans	112	15.56	28.46	5.65	0.12	0.00
Wheat	113	9.28	24.24	8.27	11.46	1.05

** ARC-CO payments and payment projections averaged across all counties and practices in Nebraska where data is available. Payments for 2014-2016 from USDA-FSA. Payment projections for 2017 based on yield and price projections from USDA-NASS, USDA-WAOB, and USDA-FSA as of October 2017. Payment projections for 2018 based on Olympic average yields and price projections from CBO as of June 2017.*

Sources: USDA-FSA, USDA-NASS, USDA-OCE, USDA-WAOB, and CBO.

Outlook

Beyond 2018, producers can look to potential changes in farm programs under a new or extended farm bill. While there are substantial budget challenges and program questions up for debate, there are widespread expectations that the commodity programs will maintain the current portfolio of ARC and PLC programs. Whether a new farm bill is completed on time or the current legislation is simply extended, the widespread expectation is also that producers will have a new decision between ARC and PLC that could be substantially different than in 2014 given the changing price outlook and expectations for support.

In summary, farm program payments have helped crop producers withstand the dramatic drop in prices thus far, but the support is projected to fall sharply by 2018. Even recognizing the limitations of commodity programs, it is obvious that ARC and PLC have been important parts of a producer's risk management strategy and bottom line. It is just as important to remember other production, insurance, and marketing decisions that all contribute to a portfolio approach to risk management.

Endnotes

Adapted from the Cornhusker Economics newsletter article. October 25, 2017. Available at https://agecon.unl.edu/cornhusker-economics/2017/nebraska-farm-program-payments-projections.

Updated information, detail, and analysis is available at http://farmbill.unl.edu.

Trends in Nebraska Land Values and Cash Rents 2017-2018

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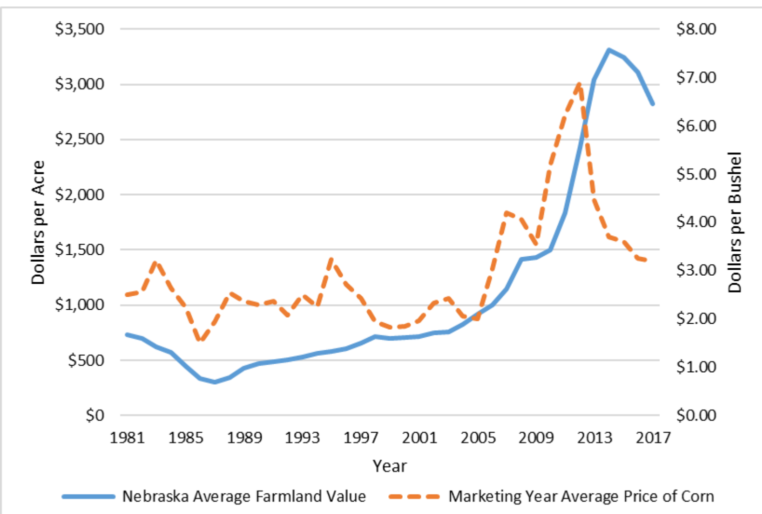
Jeff Stokes, Professor & Hanson-Clegg-Allen Chair in Agricultural Banking and Finance

Nebraska crop producers face challenging financial circumstances in 2018 with low commodity prices and the management of rented cropland. Making informed decisions when renting or purchasing cropland becomes even more important with tighter production margins for producers.

Cropland Values

The Nebraska all land average price set highest nominal (non-inflation adjusted price) in 2014 at $3,315 per acre and has since declined $495 over the last three years to $2,820 per acre during the 39-year history of the UNL Nebraska Farm Real Estate Market Surveys (Figure 1).

Figure 1. Nebraska Average Farmland Value per Acre and Marketing Year Average Price of Corn



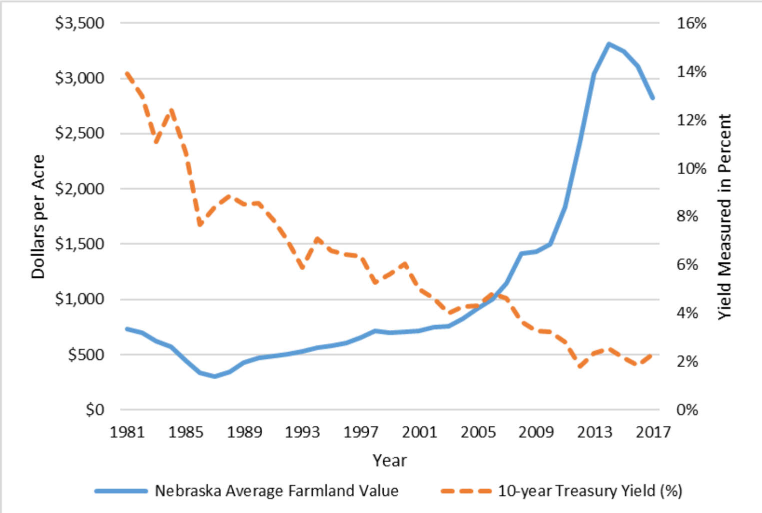
Source: Nebraska Farm Real Estate Survey and WASDE.

Record setting marketing year average price for corn of $6.89 per bushel set in 2012 declined approximately 54 percent to $3.20 per bushel in 2017. Survey members indicated the current price of commodities as a leading factor attributing to lower expectations for land values.

Another important factor influencing the value of land relates to the cost of financing new farm real estate purchases. Nebraska average farmland values and the annual yield on 10-year Treasury bonds displays this relationship (Figure 2). The yield on 10-year Treasury bonds tends to be highly correlated with the cost of borrowed funds. In general, the relationship between farmland values and the yield on Treasury bonds carry a negative tendency meaning as bond yields increase farmland values fall.

Interest rates and bond yields are positively correlated meaning an increase in the Federal Funds Rate tends to correlate with increases in rates and yields on securities with longer maturities such as the 10-year Treasury bond. In addition, expectations of a stronger economy often sends signals to investors that Treasury bonds are less appealing from a risk-return standpoint.

Figure 2. Nebraska Average Farmland Value per Acre and 10-year Treasury Bond Rate



Source: Nebraska Farm Real Estate Survey and U.S Department of the Treasury.

As capital leaves the bond market, bond prices fall and yields on those securities rise. An increase in the yield on 10-year Treasury bonds may have the effect of pushing farmland values lower as interest rates on loans increase. With the potential for interest rates to increase and net farm operating income to remain stagnant or lower, farmland values may experience more downward pressure in 2018.

Cropland Rental Rates

Rental rates across the state marked varying degrees of declines (Table 1). Dryland cropland reported a decline of 9 and 10 percent in the Northwest and South Districts, but only slightly lower rates were reported in the Northeast and East Districts. Irrigated cropland reported a decline of closer to 10 percent across the state except for the Central at about 4 percent.

Table 1. Reported Cash Rental Rates for Cropland in Nebraska: 2017 Averages

Type of Land	Agricultural Statistics District							
	Northwest	North	Northeast	Central	East	Southwest	South	Southeast
	- Dollars Per Acre -							
Dryland Cropland								
Average	29	55	215	88	195	39	72	155
% Change.................	-9	-8	-4	-8	-3	-7	-10	-6
High Third Quality…	41	67	265	120	235	56	115	200
Low Third Quality…..	23	41	170	68	155	28	56	130
Center Pivot Irrigated Cropland**								
Average	155	205	305	230	290	200	225	265
% Change.................	-9	-7	-12	-4	-9	-11	-6	-9
High Third Quality…	200	240	350	270	325	245	270	315
Low Third Quality…..	125	160	250	215	245	185	195	225

*Source: Nebraska Farm Real Estate Survey. **Cash rents on center pivot irrigated cropland assumes landowners own the total irrigation system.*

The outlook for rental rates in 2018 may be lower due also to net farm operating income being stagnant or lower with current commodity prices.

Further Readings

Nebraska Farm Real Estate Market Highlights Report: http://agecon.unl.edu/realestate

Cash Flow Budgeting for Farms and Ranches

Robert Tigner, Austin Duerfeldt, Nebraska Extension Agricultural Systems Economists

Cash flow statements and budgets are a crucial part of the farm and ranch business financial management. Cash flow statements allow farm and ranch managers to track the actual inflows and outflows of cash. Cash flow budgets are used to predict and plan for inflows and outflows of cash. By comparing the cash flow statement to the cash flow budget managers can review the implementation of the cash flow budget by looking and studying the variances. Cash flow budgets also allow farm and ranch owners to plan borrowing, credit lines, and capital purchases. Cash flow planning and analysis are standard business practices and are superior business management tools for Nebraska farm and ranch managers.

The primary use of a cash flow budget is to project the timing of cash inflows and outflows and then to plan for borrowing if shortfalls in cash flow occur. Managers can then design a borrowing and repayment plan that fits the farm or ranches income and expense timing. A cash flow budget can also point to ways to more efficiently time expense payments. For instance, if a farm sells wheat at harvest, a significant expense such as insurance or fuel needed for fall harvest might be scheduled at that time as well. This example shows one way management can avoid drawing on their personal funds or operating loan through cash flow planning. Cash flow planning might include family living costs along with farm and ranch income and expenses. Once management develops a cash flow plan, they can arrange an appropriate line of credit with a lender.

Management can use a cash flow budget as a monitor and control for cash outflows and inflows for the year. An example cash flow budget is at the end of this article (Figure 1). This example shows a cash flow budget by quarter. Cash flow budgets may also be prepared using a monthly or bi-monthly schedule as well, but are all formulated around a one-year length of time. A statement of actual cash flow is then composed as the year proceeds and managers compare that to the budget made earlier to monitor cash inflows and outflows. Managers can develop a cash flow budget in one of two ways: 1. Use last year's cash flow and adjust cash outflows and inflows by the expected change in expenses and income 2. Use enterprise budgets to build a cash flow budget. The second method is very detailed and takes into account changes in cropping and livestock production such as different crop acres or more cows to calve for the coming year.

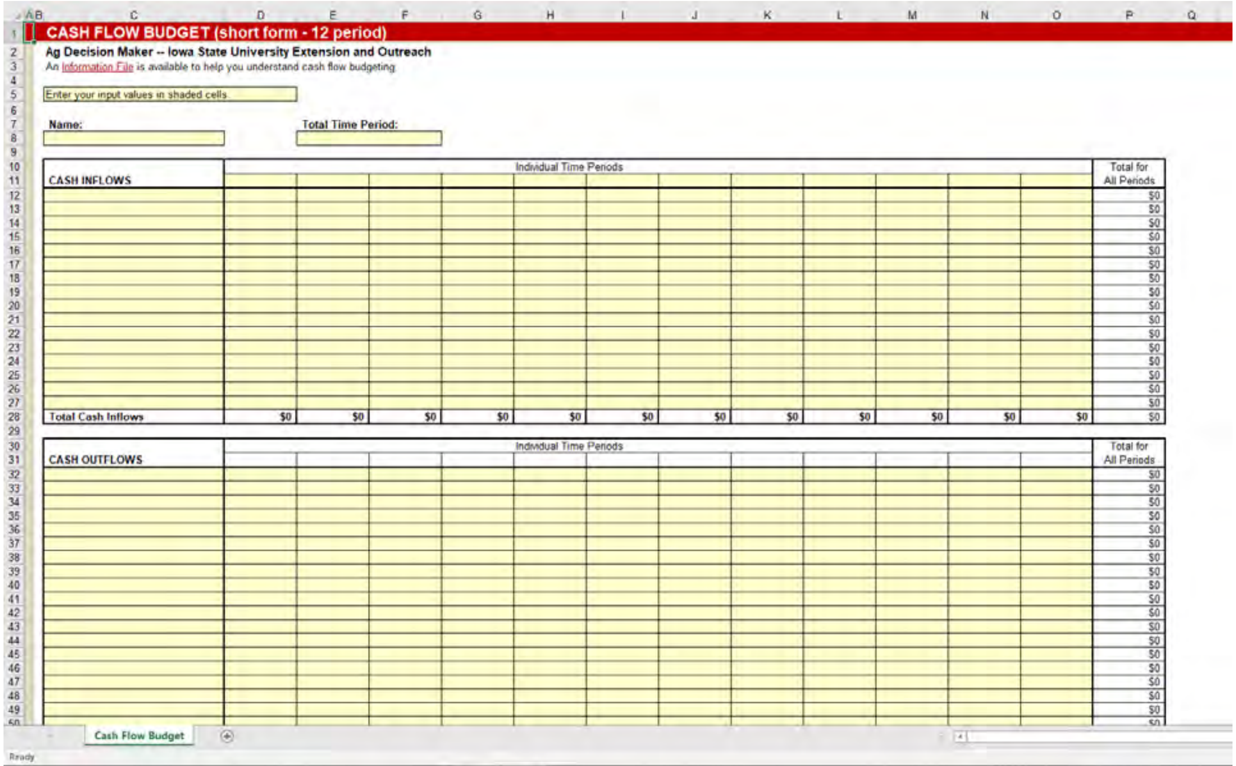
Figure 1 Cash Flow Budget Example

Sample 1. Cash flow budget (by quarter of the year)

Cash inflow	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Beginning cash balance	$5,000			
Sale of crop products		$50,000		
Sale of livestock products	25,000			
Government payments				$10,000
Total inflow	$30,000	$50,000		$10,000
Cash expenditures				
Seed	$10,000			
Fertilizer		$20,000		
Feed	10,000			
Processing			$10,000	
Marketing				$5,000
Capital purchases		10,000		
Interest			5,000	
Debt payments			10,000	
Total expenditures	$20,000	$30,000	$25,000	$5,000
Quarterly net cash flow	**$10,000**	**$20,000**	**-$25,000**	**$5,000**
Cumulative net cash flow	**$10,000**	**$30,000**	**$5,000**	**$10,000**

Source: "Understanding Cash Flow Analysis" c3-14, Iowa State University Ag DecisionMaker, https://www.extension.iastate.edu/agdm/wholefarm/pdf/c3-14.pdf,

Figure 2 Cash Flow Budget Form, Excel Spreadsheet



Source: " Cash Flow Budget," Iowa State University Ag DecisionMaker, https://www.extension.iastate.edu/agdm/wholefarm/xls/c3-14cashflowbudget12month.xlsx

Figure 3 Example Negative Cash Flow Budget

1. Enter Starting Date of the first month in DD/MM/YYYY format in the blue cell below. Today's date will autopopulate and can be changed as necessary
10/26/2017

2. Enter Opening Cash Balance	
$	**80,140.00**

Notes:

Sold a 12 row Kinze 3600 planter for $44,000, and purchase a 2014 Kinze 4900 24 row planter listed at $198,500. Net purchase terms is 198,500 minus proceeds from old planter of 44,000 minus 72,500 cash resulting in financed equipment of $82,000. 5 year loan at 4.033% interest with yearly payments of $18,463.93

Cash Flow Budget Summary					
Cash Flow Budget	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Opening Bank Balance	80,140	63,205	52,218	57,177	80,290
Total Receipts	788,000	608,900	628,700	651,500	658,200
Total Payments	804,935	619,887	623,741	628,387	621,975
Net Cash Flow	**-16,935**	**-10,987**	**4,959**	**23,113**	**36,225**
Final Bank Balance	**63,205**	**52,218**	**57,177**	**80,290**	**116,515**

When to Replant Sugarbeets: the Relationship Between Population, Yield, and Replant Timing

**Nevin Lawrence – Weed Management Specialist; Dave Reichert – WSC Agronomist;
Bob Harveson – Plant Pathology Specialist; Jeff Bradshaw – Entomology Specialist**

Early season stand loss from wind or frost can be severe enough to require replanting of a sugarbeet crop. Three years of field trials at the Panhandle Research and Extension Center were conducted to determine just how much stands need to be reduced to justify replanting.

Figure 1. A 12,000 (left) and a 42,000 (right) per acre stand of sugarbeets. Sugarbeets are typically planted at over 50,000 plants per acre, and replanting may not be justified until stands fall below 12,000 plants per acre.

Replanting of sugarbeet due to early season frost or wind damage is a common practice in the western Great Plains. Replanting delays the crop several weeks and may result in reduced sugar and root yield. However, just how much stand must be lost before replanting makes sense? To determine the replanting threshold ten separate field trials were carried out between 2014 and 2016. These trials also considered the impact of irrigation method, variety, and row spacing effect on replant thresholds.

__Treatment and Study Design__
Furrow vs Sprinkler Irrigation
22" vs 30" row spacing
Two sugarbeet varieties
Seven populations planted on May 1st
One population planted on June 1st
Sixty-four total treatments

- Beets were planted at a standard planting date at populations ranging from 12,000 to 56,000 plants per acre.
- A late planted stand was established a month later at 36,000 plants per acre.
- Replanted beets never yielded better than the standard planting date.
- Statistical modeling was used to estimate at what population level yield would equal the replanted population.
- Replanting was estimated to result in a higher yield if the original stand fell below 5,000 to 12,000 plants per acre. Or, one plant every 24 inches in 22 inch rows and one plant every 18 inches in 30 inch rows.
- Irrigation type and sugarbeet variety had little influence on the replanting threshold.

The study design only evaluated agronomic yield, which did not consider the economic costs of replanting. Additionally, all populations were uniform. In a real-world stand loss situation, stand loss would be irregular, making these results harder to implement. While it is difficult to replicate real-world stand loss in research plots, these results indicate sugarbeets are more resilient to stand loss than earlier research indicated. The difference between this study and earlier research is likely explained by better weed control and improved sugarbeet agronomics. Specifically, glyphosate-tolerant sugarbeet varieties allow control of weeds that normally would flourish in a stand loss situation, and modern varieties grow quicker and are better able to compensate for stand loss.

Is Soybean Yield Limited by Nitrogen Supply?

Nicolas Cafaro La Menza – PhD student | Patricio Grassini - Cropping Systems Specialist | James Specht - Emeritus Professor | Jenny Rees - Extension Educator | Amy Timmerman - Extension Educator | Todd Whitney - Extension Educator | Keith Glewen - Extension Educator

BACKGROUND

Soybean has a large nitrogen (N) requirement. Indeed, soybean requires about 4 times more N per bushel produced compared with corn! On average, soybean needs to absorb 4.8 lbs of N per bushel produced. Hence, a soybean crop that produces 50 bu/ac (similar to current NE state average) will need to absorb 240 lbs N per acre. In contrast, a well-managed, irrigated crop that produces 80 bu/ac will need about 384 lbs N per acre.

Except for a small dose of N fertilizer applied as "starter" in some fields, most soybean crops rely almost exclusively on N supplied by soil organic matter mineralization and N fixation. The latter is a symbiotic association between a bacteria and the plant. The bacteria fixes N from the air and makes it available for the plant in exchange for carbohydrates that come from plant photosynthesis.

As the yield levels increase, so does the N requirement, leading to uncertainty relative to the degree to which the N supplied from soil organic mineralization and fixation is sufficient to meet crop N requirements. Therefore, it seems critical to know the yield level at which soybean yield becomes limited by N supply, if it ever does. However, it is challenging to evaluate N limitation in soybean for two major reasons. First, soybean absorbs 60% of the N after R3 (beginning of pod setting), so it is difficult to ensure an ample N supply just when is really needed by the crop. Second, application of N fertilizer in soybean (and other legume crops) typically results in a decrease in N fixation. In other words, application of N fertilizer reduces N fixation so that the amount of N absorbed by fertilized versus non-fertilizer crops may be ending up the same. These two reasons help explain why yield response to N fertilizer has been found to be small and inconsistent in past soybean research!

OUR EXPERIMENTS

As a first attempt to understand the degree of N limitation across yield levels in soybean, we designed an experiment that includes (1) a 'full-N" treatment that received ample N supply during the entire soybean crop growing season and (2) a "zero-N" treatment that did not receive any N fertilizer. Our experiments were conducted in irrigated soybean in Nebraska (four producer fields located near Mead, Saronville, Atkinson, and Smithfield) and Balcarce (Argentina) from 2015 to 2017. The experiments covered a wide range of environments, with yield ranging from 40 to 90 bu/ac. Side-by-side comparison of yield in the full-N versus zero-N treatment at each site would provide a good indication about the degree of limitation across this wide yield range.

Our full-N treatment received large N fertilizers amounts (ranging from 300 to 780 lb N/ac), which were determined based on (1) site-specific yield potential as determined by climate and genetics and (2) the soybean N requirement per bushel produced (4.8 lbs N per bu). Because of the 'trade-off' between N fertilizer application and N fixation, we ignored N fixation for our calculation of N fertilizer requirements. *Again, these N fertilizer amounts were applied to test our hypothesis about N limitation in soybean and NOT to make recommendations in relation with N fertilizer application in farmer fields!*

To guarantee a high N supply during the entire growing season, the total N fertilizer amount calculated for the full-N treatment was split into five applications (V2, V4, R1, R3 and R5 stages). The amount of N fertilizer in each application was proportionally adjusted according to the expected crop N requirement at each stage: 10% at V2, 10% at V4, 20% R1, 30% at R3, and 30% at R5. In other words, we "spoon-feed" our soybean crop during the entire growing seasons to ensure that N supply was perfectly synchronized with the crop N demand.

WHAT DID WE FIND?

Figure 1 shows the comparison between measured yields in the full-N treatment (vertical axis) versus the zero-N treatment (horizontal axis). The colored symbols denote the yields of soybean at each site and year. The solid x=y line denotes equality in yield if soybean yield is not impacted by N fertilization. However, the chart's dashed line shows that soybean yield was indeed impacted by N fertilizer addition. On average, seed yield was 11% higher in the full-N treatment compared with the crops that did not receive any N fertilizer (zero-N) ***(Figure 1)***. However, the yield responses depended upon the yield level of the environment. For example, there was no seed yield difference between full-N and zero-N treatments for yield levels around 40 bu/ac. In contrast, there was a 13-bushel yield increase due to N fertilizer application at yield levels near 90 bu/ac. To summarize, our results indicate that soybean yield is indeed limited by N supply, especially in high-yield environments.

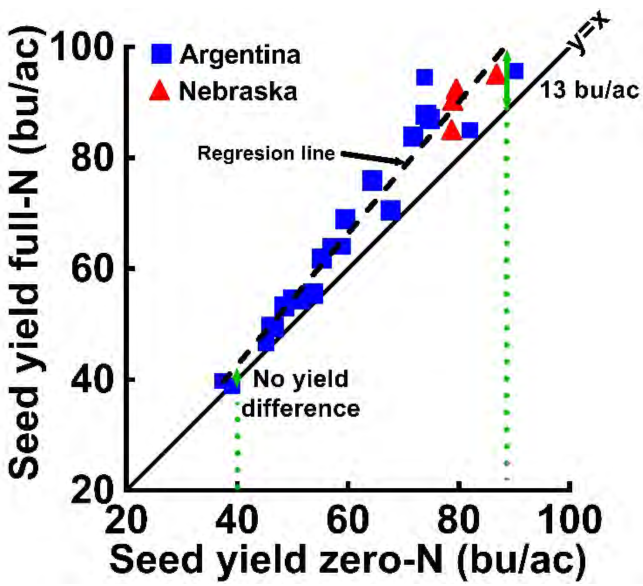


Figure 1. Seed yield in the full-N versus zero-N treatments across experiments in Argentina and Nebraska. Green arrows indicate the measured yield differences due to N fertilization at high (40 bu/ac) and low (90 bu/ac) yield levels.

N protein concentration typically decreases with higher yields. We found the opposite response in our experiments: despite higher yields, seed protein concentration was higher in the full-N *versus* N-zero treatments (36.0 *versus* 34.7%). In contrast, oil concentration decreased slightly in the full N treatment ***(Figure 2)***.

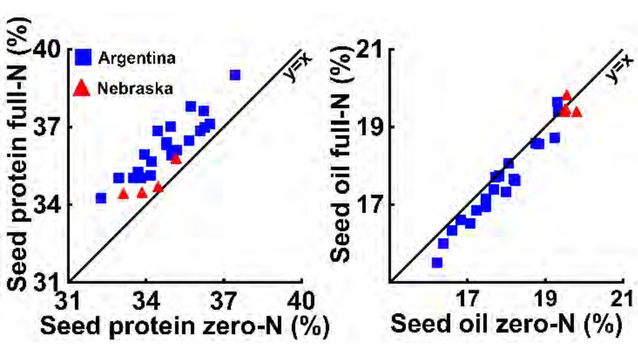


Figure 2. Seed protein (left) and oil (right) concentration (at 13% of seed moisture) in the full-N versus zero-N treatments across experiments in Argentina and Nebraska.

TAKE-HOME MESSAGES

Although our study used N rates that are far from being economically profitable and environmental sound, it clearly shows that:

- ✓ Nitrogen supply from soil organic matter mineralization and fixation are NOT sufficient to fully satisfy soybean N requirement, especially in high yield environments.
- ✓ Yield response to large N fertilizer amounts were modest and depended on the yield level of the production environment (5 bu/ac at 50 bu/ac yield level but 13 bu/ac at 90 bu/ac yield level).
- ✓ Seed protein concentration increased with N fertilizer addition, a surprising finding worthy of more research.
- ✓ As soybean yield continues to increase, the N limitation will become more and more important. Hence, future research should be directed to (1) find agronomic practices that can 'break' the trade-off between N fertilizer addition and N fixation and (2) increase N fixation.
- ✓ If you are considering to apply N in soybean, keep expectations at a reasonable (low) level and give priority to fields with consistent high yields in previous years.

References:

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- Grassini, P., Rees, J., Cafaro La Menza, N., and Specht, J., 2016. What does it take to produce 80+ bu/ac soybean? UNL Extension Circular.

Field and Season Specific N Rate Recommendation for Corn Using Maize-N Program

Haishun Yang, Crop Simulation Modeler (hyang2@unl.edu)

Determining nitrogen (N) fertilizer rate for corn is a critical part of crop management. Major factors to consider for N rate include likely yield at the end of the season, content of soil organic matter (SOM), N credits from previous season (leftover of N fertilizers, legume crop residues, irrigation water, etc), and N from manures if applied. Every major corn producing state in the US has developed its own guideline for N rate determination and the guideline is often in the form of an integrated formula. Taking Nebraska for example, the following formula has been used for many years for N rate for corn:

N rate (lb/ac) = [35 + (1.2*EY)] – [(8*NO_3) + (0.14*EY*SOM) + N credits]

In which EY is the expected yield or yield goal in bu/ac, NO_3 is the NO_3-N concentration in ppm in top 3-4 feet of soil from samples taken in the fall or spring, SOM is SOM content in %, and N credits in lb/ac is the estimated overall N contribution from sources other than SOM. Such a scheme is the result of field research over years across major areas of crop production. It represents well average cases across space and time, but may not work well for fields or seasons that deviate significantly from average cases. Two of the challenges of using such a scheme are predictions of yield for the coming season and the amount of N credits. Both vary with crop management and weather. Another hurdle of such a method is the required soil testing for NO_3-N, which is labor and time consuming. Because of the guesswork when using such a scheme, it is less quantitative and its success depends much on field experience.

Researchers in University of Nebraska – Lincoln have developed an alternative decision support tool for N fertilizer rate recommendation for corn. It is called Maize-N, a simulation model that runs in a regular Windows based personal PC (Fig. 1). Maize-N considers the same factors that affect N fertilizer rate for a crop as the conventional scheme, but it does so in a more quantitative and field and season specific manner with little dependence on field experience and soil testing (Fig. 2). As such, users can run the program (a) for individual fields to reflect the differences in crop management and soil of the fields, and (2) at the time when N rate must be determined, for instance when sidedressing several weeks after emergence.

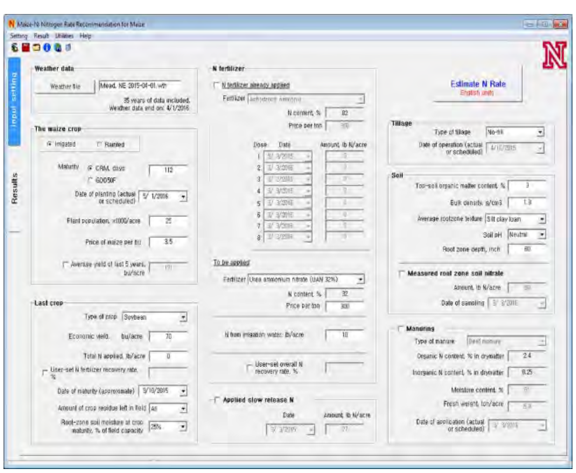

Fig. 1 Screenshot of the front page of the Maize-N model model.

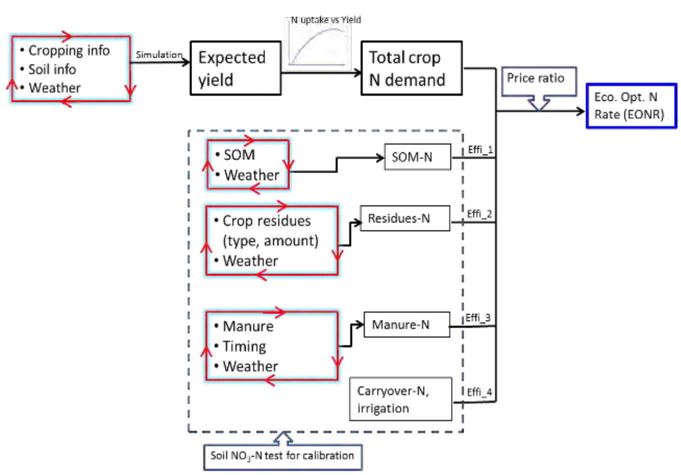

Fig. 2 Maize-N decision making process.

Maize-N provides season specific recommendation for N rate by using real-time weather data. SOM content across the Corn Belt is typically around 3~5 %. As a result, SOM can release 100 to 160 lb/ac of N that is readily available to the crop. Because SOM mineralization depends greatly on temperature, which varies from one season to another, using current season real-time weather data would lead to more accurate estimation of N contribution from SOM. In addition, the likely yield of the current season is predicted using the Hybrid-Maize model based on crop management info from users and combination of real-time weather data and long-term weather record for the location of the field.

For using Maize-N, users need to provide up-to-date weather data for the field location along with a minimum of 5 years of past weather record. For Nebraska producers, all weather data can be obtained from the High Plains Regional Climate Center at https://hprcc.unl.edu/. In addition, users need to provide last year's crop data of the field, and readily known crop info for this season, and basic soil properties every producer knows (Fig. 1). For the output, Maize-N produces not only the economically optimal N rate (EONR) for the field, but also a series of estimates that lead to the EONR, including the likely yield, total crop N uptake requirement, how much crop N comes from each of the sources, including SOM, N leftover from last year fertilizers, manures if applied, crop resides, irrigation water, etc (Fig 3). In addition Maize-N also displays dynamics course of N release from SOM, crop N uptake, and even potential N leaching (Fig. 4).

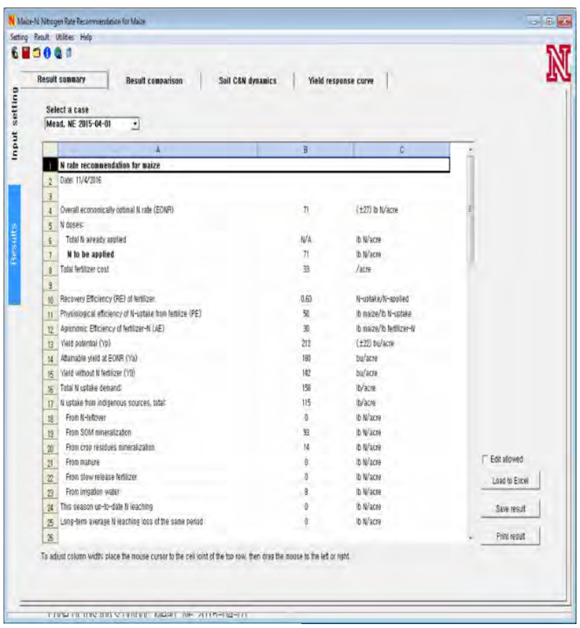

Fig. 3 Maize-N outputs

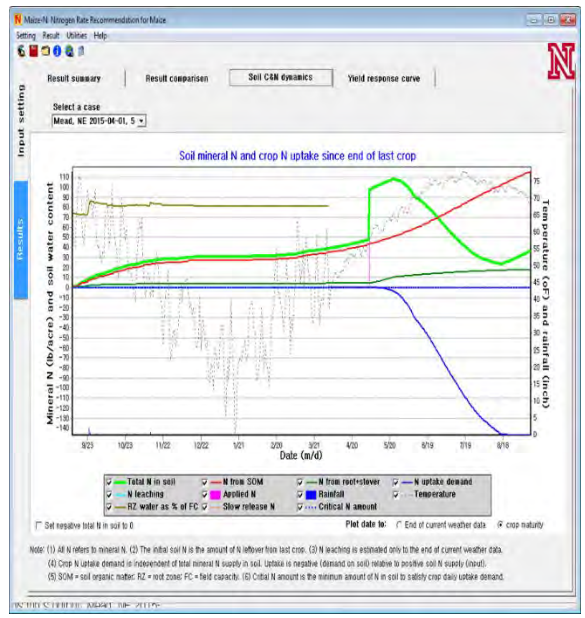

Fig. 4 Maize-N predictions of N release from SOM, crop N uptake, etc. in soil during the season.

Field trials showed that the Maize-N is not only easy to use but also superior to the current one-formula type N rate recommendation method. Maize-N also provides more insight into the soil and crop system in terms of crop yield, N demand, and N supplies from various sources in response to crop management, soil properties and up-to-date weather. Moreover, soil testing for NO_3 is optional when using Maize-N. The Maize-N software is available at https://marketplace.unl.edu/nutechmarketplace/software/maize-n.html

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Thompson et al. 2015. Model and Sensor-Based Recommendation Approaches for In-Season Nitrogen Management in Corn. Agron.J. 107, 2020-2030.

Integrating Cover Crops into a Corn and Soybean Cropping System

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Chris Proctor, Weed Management Extension Educator, University of Nebraska – Lincoln
Angela Bastidas, Graduate Student, University of Nebraska – Lincoln
Roger Elmore, Cropping Systems Agronomist, University of Nebraska – Lincoln

Modifying Corn Management to Facilitate Earlier Cover Crop Establishment

A renewed interest by farmers to include cover crops between corn harvest and planting the succeeding crop is obliging agronomists to think differently about current cropping systems. Modifying corn management practices may facilitate cover crop use increased. The objective of this research was to understand the impact of planting dates, plant populations, and corn (*Zea mays* L.) hybrid comparative relative maturity (CRM) on corn growth, kernel moisture content, and corn yield. We used mid-May and early-June planting dates; plant populations of 28000, 35000, and 42000 plant acre^{-1}; and corn CRM hybrids from 80 to 115 days. Kernel moisture of 18% was reached by early and early to medium-maturity hybrids (< 96 days) about one month earlier and medium-maturity hybrids (97 to 106 days) about 15 days earlier than late-maturity hybrids. No differences in corn yield were observed between the medium and late-maturity hybrids planted at the earliest planting date. The greatest corn yield of 234 bu acre^{-1} was obtained with a plant population of 35000 plant acre^{-1}. Increasing CRM increased corn grain yield quadratically with the highest yield of 255 bu acre^{-1} obtained with the 107 CRM hybrid planted in mid-May and 244 bu acre^{-1} by 102 CRM hybrid when is planted in early-June. Mid-May planting with a medium-maturity hybrid could optimize corn hybrid yield while permitting 15 days earlier planting of cover crops after corn harvest than current practices allow. Mid-May planting with an early to medium hybrid would penalize corn yield by 6%, but would allow cover crop planting 30 days earlier than current practices. These results provide evidence that early planting with earlier-maturity hybrids may increase the potential for use of cover crop in the corn-soybean cropping systems.

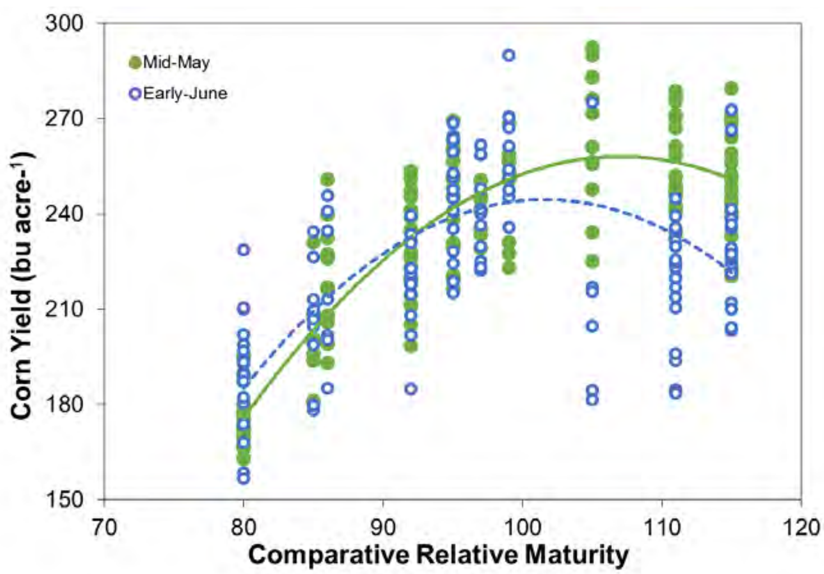


Figure 2. Effect of planting date and comparative relative maturity on corn yield averaged across years and plant population at South Central Agricultural Laboratory (SCAL), Nebraska.

The Effect of Planting Date on Rye Biomass Production

Rye (*Secale cereale* L) is the most commonly used cover crop in the midwestern United States because of its wide adaptation range and ability to grow in the fall, overwinter, and resume growth in the spring. The benefits from rye depend in large part on the amount of biomass produced between corn harvest and planting of the succeeding crop. We conducted a field study of rye planting dates based on corn harvest dates of different relative maturity hybrids and planting dates to evaluate the impact on rye biomass production, and the subsequent soybean crop. Rye was planted in 02 Oct., 09 Oct., 12 Oct., and 21 Oct. during 2015, and weekly from early Sept. to late Oct. during 2016. All plantings occurred after corn harvest. Both fall and spring biomass had the most production occurring at the earliest planting date (Figure 2). A positive linear relationship occurred between both fall and spring biomass production and growing degree days (GDD_C.) Rye biomass production was greatest when at least 600 GDD_C (base 0°C) accumulated between planting and fall sampling, and at least 975 GDD_C (base 0°C) accumulated between planting and spring sampling under South Central Nebraska conditions. This accumulation could be achieved by planting on or before 20 Sept.

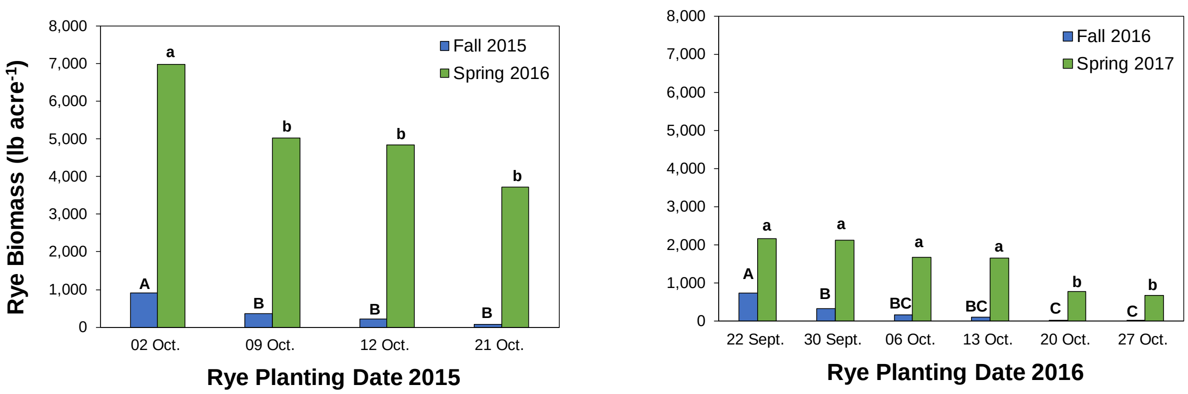


Figure 2. Effect of planting date on rye biomass production during fall and spring at South Central Agricultural Laboratory (SCAL), Nebraska. For each measurement, means with different letters indicate statistical differences at the 0.05 probability level; ns, nonsignificant.

Broadcast seeding rates for rye and hairy vetch cover crops in no-till corn and soybean systems.

Seed costs are major expenses when considering cover crops. Seeding rate recommendations for broadcast planting cover crops such as cereal rye and hairy vetch vary widely, but does increasing seeding rates lead to more cover crop biomass? Furthermore, cover crops broadcast into soybean stands may have different emergence and productivity than cover crops planted into corn stands. With this research, we determined cover crop seeding rates for high cover crop productivity in both corn and soybean systems.

Cover crops were planted at research stations near Mead and Clay Center, in late September of 2016 and 2017, by broadcasting by hand into corn and soybean. Rye seeding rates were 60, 90 and 120 lb/a. Vetch seeding rates were 40, 60 and 80 lb/a. Cover crop emergence was counted in the fall and biomass (as dry matter) was sampled in early May. All plots were no-till in 2016, but the plots at Mead were disked after cover crops termination in 2017. A significance level of 0.1 was used for statistical comparisons.

Cover crop emergence was higher in corn than in soybean. In corn, high amounts of residue and corn stubble may keep the soil surface moister and the seedling more protected from cold winds. On the other hand, in soybean, more light was reaching the seedlings, allowing the growth of many tillers in rye, especially in the low seeding rate, whereas rye planted in corn had no tillers in any of the seeding rates. In the spring, rye biomass was highest at Mead, ranging from 1,100 to 5,200 lb/a (fig. 3). Biomass of rye growing in corn approximately doubled between the lowest and medium seeding rate, but was the same for the medium and highest seeding rates. Rye biomass in soybean did not differ as much between the seeding rates, probably because the lower seeding rates had the highest number of tillers. Vetch biomass was 500 lb/a at Mead and 800 lb/a at Clay Center and did not change with seeding rates. First-year results suggest that to maximize rye biomass, plant at 90 lb/a into corn and at 60 lb/a into soybean. Vetch can be planted at 40 lb/a in either corn or soybean, but productivity is much lower than that of rye.

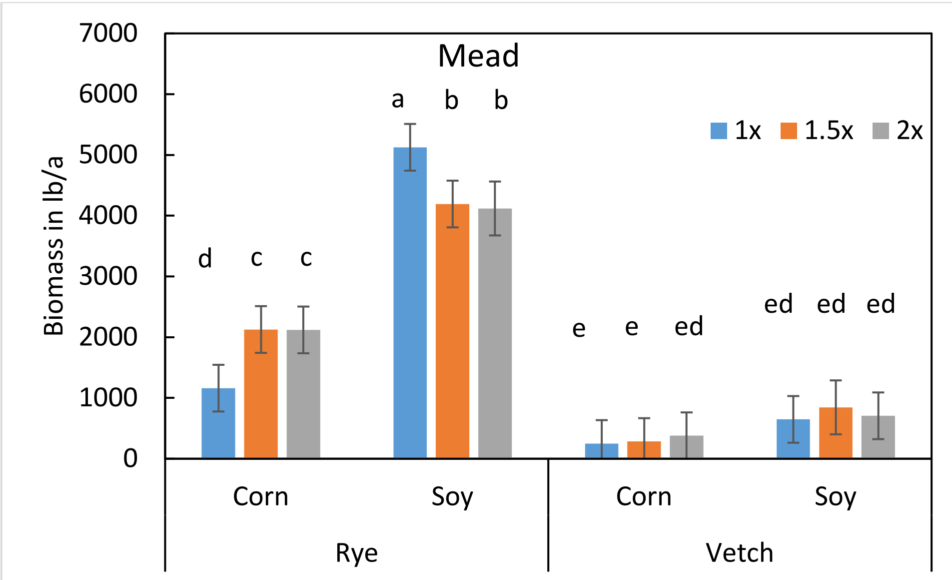


Figure 3. Cover crop biomass as dry matter at Mead on May 4, 2017. Cover crops were cereal rye (Rye) and hairy vetch (Vetch), planted into corn and soybean. Rye seeding rates were 60, 90 and 120 lb/a (1x, 1.5x and 2x, respectively) and vetch seeding rates were 40, 60 and 80 lb/a (1x, 1.5x and 2x, respectively). Bars with different letters have biomass that is statistically different from each other.

Wheat Insect Pest Update

Jeff Bradshaw and Julie Peterson,
Extension Entomology Specialists

- The wheat stem sawfly continues to be a major pest of wheat production throughout the High Plains, including Nebraska.
- Recent UNL research results reveal that a spring disc operation of fallow field edges can reduce sawfly emergence (e.g., Figure 1); however, effectiveness is limited and may have tradeoffs.
- Wheat stem sawfly surveys have revealed that sawfly parasitoids may be well established in some locations and appear to be effective biological control agents.
- Ongoing research is working to understand how sawfly parasitoids become established.
- Landscape diversity might be an important factor guiding sawfly parasitoid establishment, or some grass species might exacerbate sawfly infestations (e.g., Figure 2).
- Meanwhile wheat breeding programs at UNL and other institutions are busy developing sawfly-resistant wheat lines.
- In our region, the wheat variety Warhorse continues to be the highest-yielding of the sawfly-resistant wheat varieties.
- The 3-year average of Warhorse is only 41 bu/a; however, it is highly resistant to sawfly lodging.

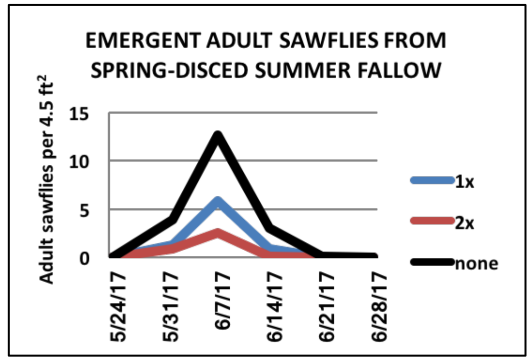


Figure 1. On-farm tillage treatments used to evaluate the impact of spring disc on sawfly emergence.

Figure 2. Landscape classifications associated with moderate sawfly pressure and low sawfly parasitism.

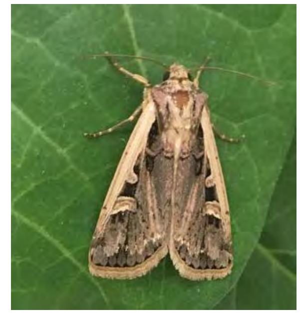
Resources for additional information

- Webcast overview of the wheat stem sawfly in wheat; (https://www.plantmanagementnetwork.org/edcenter/seminars/outreach/Wheat/Sawfly/)
- Winter wheat variety test results; https://cropwatch.unl.edu/winter-wheat-variety-test-results

The adoption of reduced tillage in wheat production systems clearly contributes to greater wheat stem sawfly populations in wheat. However, some wheat fields are imbedded within diverse landscapes that *might* facilitate conservation of biological control (e.g., parasitoids). Research is underway to understand these relationships. Meanwhile, some winter wheat varieties (e.g., Warhorse) are available, but at a yield penalty under low-infestation conditions.

Western Bean Cutworm Pest Update

Julie Peterson, Tom Hunt, Jeff Bradshaw, and Bob Wright- Nebraska Extension Entomology Specialists; Ron Seymour- Nebraska Extension Educator; Débora Montezano- Entomology PhD Student; Katie Swoboda Bhattarai- Entomology Post-doctoral Scholar



- In 2017, the western bean cutworm (WBC) was once again a major pest in corn and dry bean production for most of Nebraska. WBC continues to expand its range and was reported for the first time in 2017 as far east as Maryland and Nova Scotia, Canada.
- Fig. 1: Moth flights in 2017 began first in the eastern Platte River Valley, with black light trap catches at Clay Center peaking with 249 moths/night on July 4. Trap catches were the highest of the three sites at North Platte, which peaked with 297 moths/night on July 21. Numbers in Concord were comparably low.
- Based on anecdotal reports of lower than expected performance of pyrethroid insecticides, we have conducted bioassays to test the susceptibility of WBC larvae to the active ingredient bifenthrin (Fig. 2). Results from 2016-2017 indicate that populations of WBC from problem and non-problem sites across Nebraska do not differ significantly from one another in their susceptibility to bifenthrin; however, all sites from Nebraska are less susceptible than a population from Ontario, Canada, where pyrethroids are rarely used.
- In insecticide efficacy trials, products with diamides or indoxacarb as active ingredients performed better than pyrethroids alone. The details of these efficacy trials will be presented and discussed.
- Research on the biology of WBC while feeding on different diets has shown that WBC are able to complete development on Bt Cry1F corn, although they develop slower than larvae feeding on non-Bt corn. The implications that these results have on IPM and resistance management will be discussed.

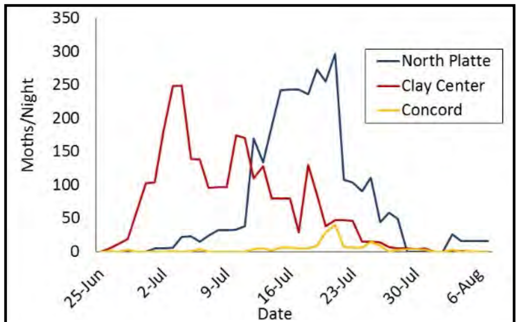


Figure 1. WBC black light trap catches from 2017 season for North Platte (blue), Clay Center (red) and Concord (yellow).

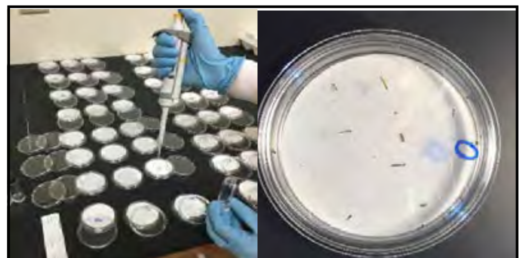


Figure 2. Applying bifenthrin to petri dishes to test susceptibility of newly hatched WBC larvae. Photos: D. Montezano

Resources for additional information:

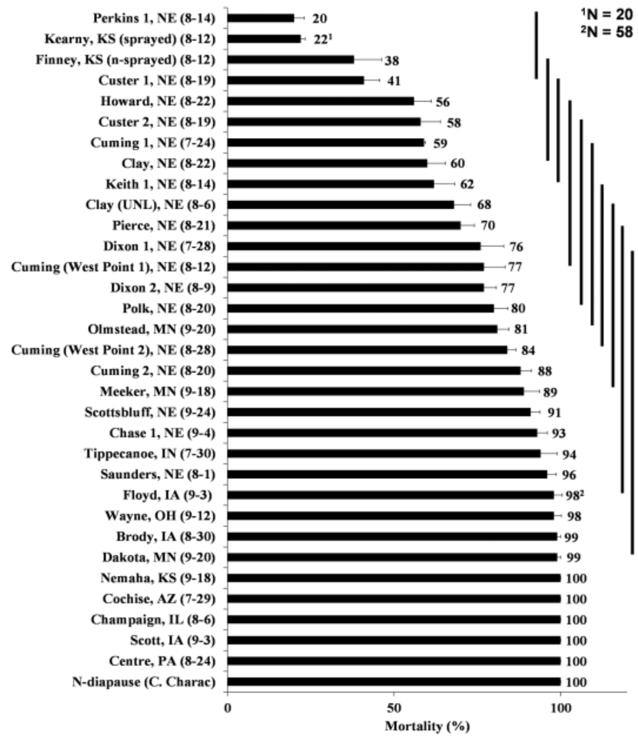
- Webinar from Plant Management Network on WBC IPM: https://www.plantmanagementnetwork.org/edcenter/seminars/corn/WBCPestStatusIPMOptions/

Our understanding of western bean cutworm biology and how this pest responds to management practices such as insecticide use and Bt traits continues to evolve. Although Nebraska populations of WBC are less susceptible to pyrethroids than caterpillars from Canada, insecticide resistance does not appear to be the only factor in reports of poor field performance for pyrethroids.

Corn Rootworm Management Update

Robert Wright, Julie Peterson, Thomas Hunt, Jeff Bradshaw, Nebraska Extension Entomology Specialists; Justin McMechan, Nebraska Extension Crop Protection and Cropping System Specialist; Lance Meinke, Professor of Entomology; University of Nebraska-Lincoln

- Corn rootworm continues to be a problem for Nebraska growers who rotate infrequently. Additionally, resistance to insecticides and some Bt corn reduces efficacy of these important tools in some fields.
- UNL & KSU research (Periera et al. 2015) shows that adult corn rootworms have reduced susceptibility to bifenthrin insecticide in southwest KS and southwest NE; areas where continuous corn is common and this active ingredient is frequently used at planting time (Capture LFR, others) or as a foliar insecticide (Brigade, others).



- Four types of Bt proteins target corn rootworms: Cry3Bb1, mCry3A, eCry3.1Ab, and Cry34/35Ab1. In multiple counties across Nebraska, greater than expected injury has been observed or resistance confirmed when single trait Cry3Bb1 or mCry3A hybrids have been planted for more than three consecutive years.
- Cross-resistance between the Cry3Bb1, mCry3A, and eCry3.1Ab proteins exists. For this reason, in areas with a history of greater than expected damage to hybrids with Cry3Bb1 traits, such as YieldGard Rootworm or VT Triple Pro, we do not recommend hybrids in continuous corn that express only mCry3A or mCry3A/eCry3.1Ab proteins, without additional control practices.
- The Cry34/35Ab1 protein, expressed either singly or in a pyramid (such as Herculex RW or SmartStax, respectively) is still performing well in most Nebraska locations.

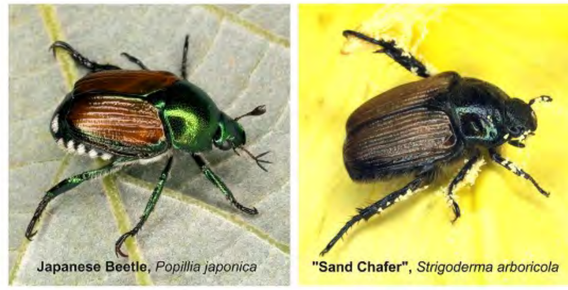
Resources for additional information

- o **Insecticide mode of action classification for Nebraska field crops**; NebGuide G2066; http://extensionpublications.unl.edu/assets/pdf/g2066.pdf
- o **Insecticide Resistance Action Committee** (IRAC) (irac-online.org)
- o **Handy Bt Trait Table** (http://msuent.com/assets/pdf/BtTraitTable15March2017.pdf)
- o **Pereira AE, Wang H, Zukoff SN, Meinke LJ, French BW, Siegfried BD (2015)** Evidence of Field- Evolved Resistance to Bifenthrin in Western Corn Rootworm (*Diabrotica virgifera virgifera* LeConte) Populations in Western Nebraska and Kansas. *PLoS ONE*10(11): e0142299. doi:10.1371/journal. pone.0142299

Use of diverse tactics on a farm is the best strategy to manage rootworms.   Periodic crop rotation out of corn can greatly reduce rootworm populations.   Avoid repeated use of the same insecticide products and Bt corn proteins to avoid development of resistance, and maintain efficacy of these important management tools.

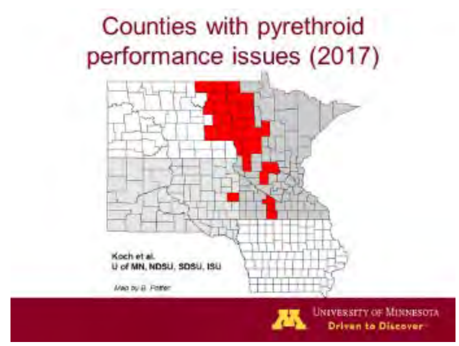
Northeast Nebraska Insect Pest Update

Thomas Hunt, Nebraska Extension Entomology Specialist;
Keith Jarvi, Wayne Ohnesorg, Nebraska Extension



- Japanese beetles are gradually becoming a pest of corn and soybean in Nebraska. While they are not yet a significant problem in northeast Nebraska, we expect numbers to increase in the coming years. The beetles defoliate soybeans, and clip silks in corn. If silk clipping occurs to fresh silks, kernel development may be affected. In Nebraska, we have a Japanese beetle look-a-like, the sand chafer. Sand chafer adults are not a problem in Nebraska crops, so it is important to learn the difference between these two beetles.

- Painted lady and other caterpillar species are common defoliators in Nebraska soybeans. They make up a complex of defoliators that may require management, but occasionally a single species reaches economically damaging levels. Caterpillar populations are typically regulated by disease; however, if environmental conditions are right, the populations can increase significantly. Besides the painted lady caterpillar, some of the most common caterpillars we see in Nebraska are loopers, green clover worm, yellow woolybear, and silverspotted skipper.



- There have been reports in Minnesota and surrounding areas of less than expected control of soybean aphids by pyrethroids, and in a few cases chlorpyrifos. Two pyrethroids that have shown significantly less than expected mortality in bioassays are λ-cyhalothrin and bifenthrin. While no confirmed insecticide resistance has been reported in Nebraska, growers should monitor their fields after insecticide treatment because many of our summer migrants likely come from southwest Minnesota and northwest Iowa.

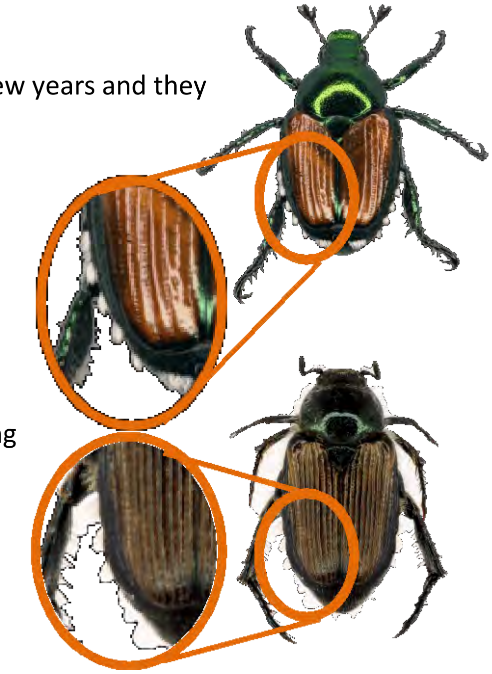
Resources for additional information

- Managing soybean defoliators; NebGuide G2259; http://extensionpublications.unl.edu/assets/pdf/g2259.pdf
- Soybean aphid management in Nebraska; NebGuide G2063; http://extensionpublications.unl.edu/assets/pdf/g2063.pdf
- Soybean aphid speed scouting; Extension Circular 1582: http://extensionpubs.unl.edu/publication/9000016368033/soybean-aphid-speed-scouting-spreadsheet/ or Apple devices: http://itunes.apple.com/us/app/aphid-speed-scout/id454600279?mt=8 or Android devices: https://play.google.com/store/apps/details?id=edu.unl.aphidspeedscout

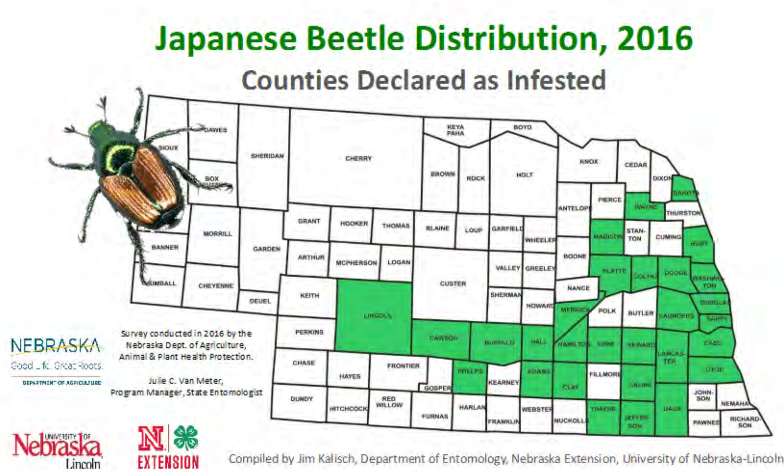
There are numerous species of insect pests in Nebraska crops, some new and some reoccurring. The best way to reduce the injury of these pests is 1) regularly scout your fields, 2) use management guidelines recommended by Nebraska Extension, and 3) keep abreast of current Nebraska agricultural issues in the *CropWatch* newsletter (https://cropwatch.unl.edu/).

Japanese Beetle in Corn and Soybeans

Justin McMechan, Nebraska Extension Crop Protection and Cropping System Specialist; Robert Wright, Julie Peterson, Thomas Hunt, Jeff Bradshaw, Nebraska Extension Entomology Specialists



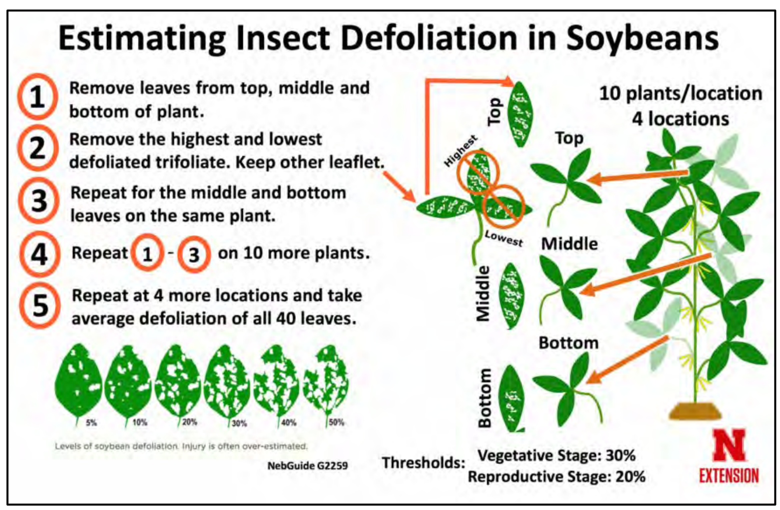
- The distribution of Japanese beetles has been increasing over the past few years and they are more frequently found in corn and soybean fields.
- Adult Japanese beetles have one generation per year and typically begin emerging in mid-June and continue for several weeks.
- Japanese beetles can sometimes be confused with false Japanese beetle or sand chafer. The sand chafer is native to Nebraska and typically found along the Platte River valley and other valleys.
- The Japanese beetle is similar in size to the sand chafer; however, Japanese beetles have a metallic green head and white tufts of hairs along their abdomen.
- Adults typically feed in clusters due to sex pheromones given off by females and volatiles emitted by damaged plants.
- In corn, adults will defoliate leaves but economic losses usually occur due to extensive silk clipping.
- In soybeans, yield losses are typically attributed to adults skeletonizing soybeans leaves.
- In soybeans, insecticide applications are recommended when leaf defoliation exceeds 30% during vegetative and 20% during the reproductive stage.
- Additional information can be found in Managing Soybean Defoliators, NebGuide G2259. http://extensionpublications.unl.edu/assets/pdf/g2259.pdf
- The University of Illinois Extension recommends that corn ears with three or more Japanese beetles, silks clipped to less than ½ inch and pollination at less than 50% completion should consider an insecticide application.
- Japanese beetles are not equally distributed in fields, with the highest populations occurring at the field margins.
- Information on insecticide options is available in the 2016 Guide to Weed Management from the University of Nebraska.



Large Populations of Painted Lady Butterflies

Justin McMechan, Nebraska Extension Crop Protection and Cropping System Specialist; Robert Wright, Julie Peterson, Thomas Hunt, Jeff Bradshaw, Nebraska Extension Entomology Specialists

- Large populations of painted lady butterflies were seen across the state raising concerns about whether or not the larvae form (thistle caterpillars) of this insect would cause damage to soybean fields.
- Growers should **not** apply pesticides to control painted lady butterflies, however, they should scout soybeans fields for leaf defoliation from thistle caterpillars and other insects.
- Painted lady butterflies lay single eggs on soybean plants with eggs hatching in about 7 days.
- After hatching, larvae will feed for 2-4 weeks with 97% of their consumption occurring in the last two larval instars.
- Larvae are typically found in the upper canopy with damaged plants usually occurring at the edge of a field.
- The larvae form webs by tying leaves together, creasing a protective area from them to feed.
- Larvae will pupate over a period of 7-17 days with approximately 2 generations per year in the Midwest.
- An accurate estimation of soybean defoliation is critical for determining if an insecticide application is necessary.
- Insecticide applications can be made when defoliation exceeds 30% in the vegetative stage and 20% in the reproductive stage.
- Painted lady or thistle caterpillars are found on over 100 plant species
    - Soybeans
    - Cocklebur
    - Canada Thistle
    - Sunflowers
    - Aster
    - Ironweed
    - Red Clover, etc.



More information on managing insect defoliators in soybeans can be found in NebGuide G2259 http://extensionpublications.unl.edu/assets/pdf/g2259.pdf

Insects in Cover Crops

Justin McMechan, Nebraska Extension Crop Protection and Cropping System Specialist;
Robert Wright, Julie Peterson, Thomas Hunt, Jeff Bradshaw,
Nebraska Extension Entomology Specialists

- Cover crops are becoming increasing popular in crop production systems as a means to reduce soil erosion, increase soil organic matter, conserve nitrogen, and suppress weeds.
- Integration of cover crops into a cropping system can potentially alter insect activity and abundance by
  - Increasing beneficial insects (predators, parasitoids)
  - Harbor potential pests that may damage the subsequent cash crop
  - Create new pests as a result of a green bridge between a cover crop and cash crop
- Insect pests that have been associated with cover crops
  - Green cloverworm
  - Japanese beetle
  - Bean leaf beetle
  - Stink bugs
  - True armyworm
  - Black cutworm
  - Seed corn maggot
  - Wireworms
- Beneficial insects reported in cover crop studies are
  - Ground beetles
  - Lady beetles
  - Hover flies
  - Spiders
- Insect activity and impact on a subsequent cash crop is complex due to the interaction of a number of different factors such as
  - cover crop species, planting date and method of termination
  - timing between termination of cover crop and planting cash crop
  - environmental conditions
  - cropping history
- In 2017, wheat stem maggot was found damaging early-season corn planted into wheat or rye cover crops in the central and eastern part of the state
  - In all cases, damaged fields had a cover crop that was still alive at the time of corn planting
  - In some cases, small portions of fields were planted to a cover crop (Fig 1).

Figure 1. Rye cover crop planted in small section for soil erosion. Center of photo shows the absence of cover crop and normally developing corn plants.

In such situations, infested and damaged plants were confined to these areas occurring within 1-2 feet of the cover crop.

- 2-30% of corn plants in fields were damaged showing dead heart symptoms (Fig. 2a) and excessive tillering (Fig. 2b).
- Dissection of damage plants revealed larvae ranging from 3-6 mm in size (Fig. 3a).
- Whole plant samples were collected and larvae were reared to adult for species identification.
- Little to no information is available on wheat stem maggot in cover crops.
- Greenhouse studies on corn infested with wheat stem maggot adults (Fig .3b) and eggs (Fig .3c) have not resulted in significant damage to corn plants, suggesting that infestation occurred as a result of larval movement between cover crop and corn.

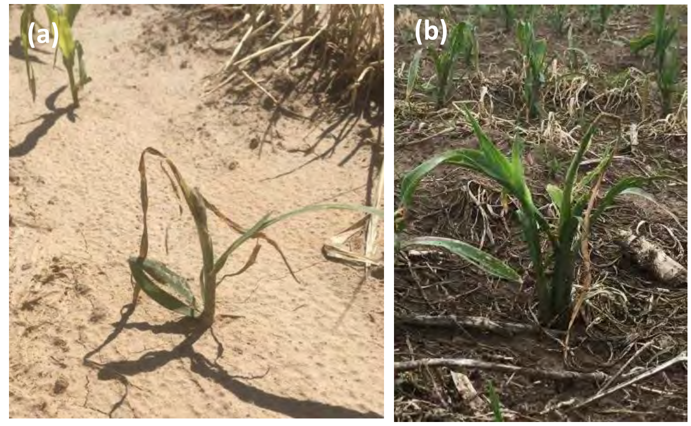


Figure 2. Wheat stem maggot damage on corn plants with (a) dead heart symptoms and (b) excessive tillering.

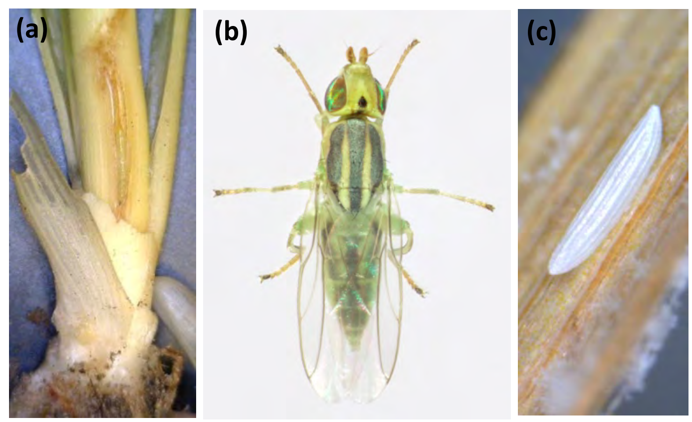


Figure 3. Wheat stem maggot larvae (a) found in damaged corn plant, adult reared from whole plant sample (b) and egg on wheat leaf (c).

Applying Pesticides Safely

Clyde L. Ogg, Pesticide Safety Educator, Frank Bright, Extension Assistant, and Greg Puckett, Extension Assistant

The world of pesticides is continually evolving. In spite of this, there are many basic principles that commercial and noncommercial applicators should always follow when handling or using pesticides.

It is vital to become familiar with how a product should be used by reading and following its label in order to apply a pesticide properly. The label also provides information about the necessary protective clothing needed when mixing and loading or applying that pesticide, and other precautions that should be taken, such as protecting non-targets like fish, bees, pets, wildlife, livestock or endangered species. Proper storage, transportation, and disposal procedures for a pesticide can also be found there. Remember that the label is the law!

Ensuring the health and safety of applicators and workers is essential. Using personal protective equipment required by the label and following the Worker Protection Standard can help applicators and employers comply with pesticide laws and regulations. An applicator using proper notification procedures about restricted entry intervals and time of application provides the information necessary for an employer to inform and protect employees who may be working in a pesticide treated area. If there is an accidental poisoning or exposure, refer to the pesticide's label for help, consult a medical professional, and call the Poison Center (800-222-1222), National Pesticide Information Center (800-858-7378), or other pesticide helpline to report the incident.

For more information on these and other related topics, see the following NebGuides and Extension Circulars:

- *Pesticide Laws and Regulations G479*
- *Worker Protection Standard for Agricultural Establishments EC3006*
- *Nebraska Pesticide Container and Secondary Containment Rules G2033*
- *Understanding the Pesticide Label G1955*
- *Spray Drift of Pesticides G1773*
- *No Drift Zone: Driftwatch Brochure*
- *Protective Clothing and Equipment for Pesticide Applicators G758*
- *Pesticide Safety: Choosing the Right Gloves G1961*
- *Maintaining and Fit Testing Cartridge Respirators for Pesticide Applications G2083*
- *Pesticides and the Endangered Species Protection Program G1893*
- *Protecting Pesticide Sensitive Crops G2179*
- *Bee Aware: Protecting Pollinators from Pesticides EC301*
- *Rinsing Pesticide Containers G1736*
- *Cleaning Pesticide Application Equipment G1770*
- *Managing Pesticide Spills G2038*
- *Managing the Risk of Pesticide Poisoning & Understanding the Signs & Symptoms EC2505*
- *Safe Transport, Storage, and Disposal of Pesticides EC2507*

The Pesticide Safety Education Program (PSEP), through the University of Nebraska–Lincoln Extension, is responsible for developing and revising training programs and materials for the commercial/noncommercial applicator. The UNL PSEP website offers a wide variety of resources for the pesticide applicator, including links to register for initial licensing and recertification training, purchase training manuals, and the NebGuides and Extension Circulars listed earlier. For more information:

- Visit the Pesticide Safety Education Program website at http://pested.unl.edu
- Call the Pesticide Safety Education Program Office toll-free at 800-627-7216 or 402-472-1632 for questions about training dates, study materials, or pesticide safety education.
- Contact the Nebraska Department of Agriculture toll-free at 877-800-4080 or 402-471-2394 for questions on regulatory issues, license status, or compliance interpretation.
- Connect with us on social media:

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Wheat Disease Update: Wheat Streak Mosaic and Stripe Rust

Stephen Wegulo – Extension Plant Pathologist

Because of the widespread occurrence and severe epidemics of wheat streak mosaic and stripe rust in Nebraska in 2017 and 2015-2017, respectively, this wheat disease update is devoted to these two diseases.

Wheat streak mosaic is a disease caused by wheat streak mosaic virus (WSMV). Wheat fields were affected throughout the state in 2017. However, the most severely impacted part of the state was the southern Panhandle where severe symptoms developed (Figure 1) and total loss occurred in some fields.

WSMV is transmitted by wheat curl mites (WCMs) which also transmit two other viruses: High Plains wheat mosaic virus (HPWMoV) and Triticum mosaic virus (TriMV). WSMV is the most predominant and widespread. Research conducted at the University of Nebraska-Lincoln has shown that TriMV often occurs together with WSMV and all three viruses can also occur together. When two or all of the three viruses occur in the same crop, symptoms are more intense and yield loss is much higher than in the presence of one virus.

Figure 1. Severe wheat streak mosaic in a grower's field in Deuel County in the southern Panhandle of Nebraska on May 15, 2017.

WSMV risk factors

1. The highest risk is volunteer wheat that emerges in wheat fields just before harvest following a hail storm. The hail shatters grain that is mature enough to germinate. Following germination, WCMs move from the maturing wheat crop to the young volunteer and both the mites and virus multiply on it throughout the summer. Volunteer wheat in summer crops such as sunflower also adds to the risk of WSMV.
2. Crops or grassy weeds that are hosts of WCMs or WSMV also pose a risk if they are allowed to grow past fall wheat emergence. Crops other than wheat that are hosts of WCMs or WSMV include corn, rye, oats, barley, sorghum, and foxtail millet. Grassy weeds that are hosts include jointed goatgrass, downy brome, sandbur, crabgrass, barnyardgrass, stinkgrass, witchgrass, and green foxtail.
3. A cool, wet summer favors growth of volunteer wheat and other hosts of WCMs or WSMV, as well as survival and reproduction of WCMs. It also prolongs the period of growth of summer crops that are hosts of WCMs or WSMV, resulting in the overlap of these crops with fall planting of wheat.
4. A prolonged fall with above normal temperatures as in 2016. During such a fall, WCMs as well as WSMV remain active, reproduce, and spread for a longer time and at higher levels compared to a normal fall, causing severe damage to the wheat crop. This damage is exacerbated if a warm fall is followed by a mild winter.
5. Early planting of wheat poses a significant WSMV risk. It allows more time for mites to infest wheat, multiply on it, and transmit WSMV to it, as well as more time for WSMV to multiply within the wheat crop during favorable warmer temperatures.

Management of WSMV

1. Controlling volunteer wheat, especially pre-harvest volunteer that emerged in wheat fields or summer crops, is critical. Post-harvest volunteer should also be controlled. Volunteer wheat should be completely dead at least two weeks before fall planting.
2. Control grassy weeds in and close to fields to which wheat will be planted in the fall.
3. Avoid planting wheat too early. Instead, plant at the recommended date for your area.
4. Avoid planting wheat next to late maturing summer crops that are hosts to WCMs or WSMV, such as corn, foxtail millet, sorghum, or small grain cover crops.
5. Plant wheat varieties with greater resistance or tolerance to WSMV that are adapted to your area or region. Although most varieties grown in Nebraska are susceptible, a few have good resistance or tolerance.
6. Plant high risk fields last; these are fields adjacent to grassy weeds and late maturing host crops such as corn.

Stripe rust is caused by the fungus *Puccinia striiformis* f. sp. *tritici*. It has become increasingly common in the south central and central Great Plains. The most recent major epidemics of the disease in Nebraska occurred in 2010 and 2015 (Figure 2). Varying levels of severity and prevalence have occurred almost yearly since 2010. Yield loss due to stripe rust can be as high 40% or greater.

Figure 2. Severe stripe rust in a grower's field in Kimball County in the southern Panhandle of Nebraska on June 10, 2015.

Stripe rust risk factors

1. A high inoculum load in early spring in southern states where the wheat rust pathogens overwinter.
2. A prolonged warm fall followed by a mild winter. These conditions favor fall infections as occurred in the fall of 2016 and elevate the risk of stripe rust overwintering in Nebraska.
3. Grassy weed hosts and volunteer wheat enable stripe rust to survive well past wheat harvest, thereby providing inoculum for fall infections.
4. Because stripe rust is favored by cool temperatures, a cool, wet spring is ideal for infections and disease spread within and between wheat fields.

Management of stripe rust

1. Plant resistant varieties that are adapted to your area.
2. Avoid planting wheat too early in the fall as doing so favors fall infections which if severe can damage the wheat crop and elevate the risk of overwintering.
3. Scout wheat fields starting early in the spring for early detection which will enable you to take timely management measures to prevent disease development and spread within your field.
4. Monitor stripe rust reports in states south of Nebraska to help you prepare for it.
5. Apply a fungicide. In a high risk situation (stripe rust detected early in the spring and a wet, cool spring), two sprays may be needed, one in early spring and a second one to protect the flag leaf. Do not spray for stripe rust in the fall except in the very rare situation where infections are very severe. Even then, consult an extension specialist for a recommendation.

Specialty Crops Disease Update – 2018

Robert M. Harveson, Extension Plant Pathologist, Panhandle REC, Scottsbluff

Introduction

Environmental conditions often have strong influences on the occurrence of many diseases and their prevalence and distribution. This concept as readily illustrated for specialty crops in western Nebraska and certain diseases encountered during the 2017 growing season. The weather in 2017 was similar to that of both 205 and 2016. Rainfall in spring and early summer was plentiful throughout the region, allowing good soil moisture for emerging crops. Cooler than normal temperatures were also present, which delayed crop development in sunflowers and dry beans. For example, there were several weeks in mid-late September and early October that were cloudy, overcast with light rains and little sunshine.

This climate then played a major role on the development of numerous diseases and other plant production problems during the season. Several thunderstorms with hail and tornadoes in June caused widespread damage to fields scattered throughout the Panhandle. This was followed by high levels of bacterial diseases (wilt, common blight) 7-10 days later. Dry bean and peas were the crops most severely affected. This report will summarize some of the major and unusual disease/pest occurrences encountered during 2017 for sugar beets, dry beans, sunflowers, potatoes, and dry yellow peas and other pulse crops.

Sugar Beets

Diseases of sugar beets in general in 2017 were not as severe as recent years. However, due to the higher rainfall levels, Aphanomyces root rot was seen later in the year and at harvest. However, we continue to evaluate the integration of multiple methods for optimal management of Rhizoctonia root and crown rot. This is considered to be the most widespread and commonly occurring disease in Nebraska, and thus arguably the most important. Cercospora leaf spot was not a major problem this year, being sporadically found region-wide. It did appear in isolated areas later into September with the additional moisture accompanying several rain events. The most severe damage from this disease is most often observed when night temperatures (midnight to 7 AM) exceed 70 F, and in general it was too cool at night for optimal disease development during 2017.

Dry Beans

Dry beans in 2017 were strongly affected by several bacterial diseases. Multiple thunderstorms with high winds, hail and tornadoes in June caused widespread damage to fields scattered throughout the Panhandle. In many cases in Box Butte Co., entire fields were destroyed and abandoned. Due to these storms, bacterial diseases were found a week to 10 days later. Bacterial wilt was particularly widespread, a disease we have not seen to this extent in several years. The cooler weather further resulted in widespread, white mold epidemics problems, late in the season, with one rare occurrence of a wet weather-oriented disease called gray mold.

Dry Yellow Peas

Interest in this crop continued to grow in 2017, with an estimated 70,000 acres planted. We also completed a 3 year study to survey Nebraska production fields to determine the most prevalent and damaging diseases. The peas, like the dry beans were most commonly affected by a complex of several bacterial diseases. We are unsure of all members of this complex, but the brown spot pathogen, *Pseudomonas syringae* pv. *syringae* was the one most frequently identified. Several other bacterial pathogens found over the last 3 years are currently being characterized. We also identified low levels of root rots due to species of *Rhizoctonia, Fusarium,* and *Pythium*, but they are not major constraints at this point for which to be concerned.

Cowpeas

Cowpeas, also known as black-eyed peas, are another relatively new crop in Nebraska that shows some promise, and interest in its cultivation is gaining in popularity. Similar damage by bacterial diseases was observed from multiple fields in 2017 following thunderstorms. Bacterial wilt and common blight were the primary diseases seen. We also believe that this is the first documentation of bacterial wilt on this crop under natural fields conditions and plan to publish early in 2018.

Chickpeas

Chickpea production in Nebraska has been sporadic over the last 15 years due to a serious fungal disease called Ascochyta blight. It has traditionally been the primary limiting factor and we continue to study new methods for its management, including new fungicides and developing new cultivars with better disease tolerance. After more than 10 years of research, a new cultivar was released in 2017 by Carlos Urrea with high levels of resistance called 'New Hope'.

Sunflowers

The thunderstorms also affected sunflowers in Box Butte and Sheridan Counties in 2017. We were alerted to some abiotic stresses observed in these locations that were a direct effect of the storms. The high winds caused lodging of plants in several fields. Two fields specifically were damaged by wind combined with the added problem of soil compaction. This made them more susceptible to falling over on the ground due to poor growth of severely restricted roots. The cooler weather was also responsible for scattered outbreaks of white mold and Phomospis stem canker, the latter of which is becoming a major threat throughout sunflower growing areas of North and South Dakota.

We also have now tentatively identified a novel virus disease from Nebraska that is apparently new to science and never before reported. It has not been named, but is a member of the family Tombusviridae, based on molecular and morphological characterizations. The hail storms also contributed to appearances of the Rhizopus head rot disease in affected areas of western Nebraska.

Potatoes

We saw no major problems to commercial potato production in 2017. From our trial plots we did identify both late blight and early blight (two commonly occurring diseases). We continue to evaluate new fungicides for efficacy in managing these two fungal diseases. We also observed an insect- related problem called psyllid yellows. After the insect feeds on potato leaves, the tops become wilted, dry up, and die. This damage is due to a toxin that is inserted into leaves during the feeding process. We have encountered this problem the last several years in our potato trial plots, and it reappeared again in 2017.

Corn Disease Update

Tamra A. Jackson-Ziems, Extension Plant Pathologist

Bacterial Leaf Streak

Bacterial leaf streak (BLS), caused by *Xanthomonas vasicola* pv. *vasculorum*, was reported for the first time in the United States in Nebraska in 2016. Since then, the disease has been confirmed in 60 Nebraska counties and 8 additional states, including Colorado, Kansas, Illinois, Iowa, Minnesota, Oklahoma, South Dakota, and Texas. Previously, the pathogen had only been confirmed on corn in South Africa and on sugarcane in numerous other countries around the world. Numerous other grass and palm hosts were identified in other countries, as well, including sorghum species. Results from additional host range testing conducted in Nebraska also confirmed several additional crop, weed, and native perennial grass species as hosts. Symptoms on corn can be difficult to differentiate from other diseases, especially the gray leaf spot fungal disease. Typical symptoms of the disease on corn and other hosts are narrow interveinal streaks that can appear bright yellow when backlit. The pathogen overwinters in infested crop debris thus, disease develops in the same areas repeatedly when susceptible hybrids are grown and favorable weather conditions persist. Severity of the disease varies considerably on corn hybrids, particularly on some popcorn hybrids that can be quite susceptible. High relative humidity and leaf wetness favor disease development. Results from additional research trials will be shared, including yield trials and mitigation experiments evaluating the effects of corn-soybean rotation sequences and tillage regimes.

Goss's Bacterial Wilt and Blight

Goss's bacterial wilt and blight was more common in 2017 than in recent years. Lesions often have small, dark "freckles" and a water-soaked appearance on the edges and may appear similar to other fungal diseases, such as Northern Corn Leaf Blight and Diplodia Leaf Streak. The bacteria causing Goss's bacterial wilt and blight overwinter in the infested crop residue from the previous season(s). Development of the disease again this year was most often in fields where corn sustained injury caused by severe weather, especially hail and wind storms. These bacteria commonly utilize plant wounds to infect and cause disease. Development of the disease again in 2017 was a reminder that the pathogen is still widespread throughout much of Nebraska and capable of causing disease even if we haven't observed disease in one or several years. With this in mind, producers with fields that have a history of the disease should still carefully select and plant resistant corn hybrids in those fields that have a high level of resistance to Goss's bacterial wilt and blight to avoid severe disease that could impact yield. Crop rotation and tillage, where practical, may also help to reduced overwintering inoculum and disease severity.

Diplodia Leaf Streak

In 2017, Diplodia (Stenocarpella) leaf streak, caused by the fungus *Stenocarpella macrospora* (syn. *Diplodia macrospora* and *S. zeae*) was confirmed in samples from Madison and Platte Counties in eastern Nebraska. This fungal disease has been previously identified in several additional states in the U.S., but is the first time it was been confirmed on corn samples from Nebraska. The disease was reportedly at low incidence and severity in these locations. The symptoms of this disease are similar to those of some other common diseases that will make it difficult to recognize. For example, the large tan lesions caused by Diplodia leaf streak may look similar to the large lesions of northern corn leaf blight or Goss's bacterial wilt and blight. Lesions may begin as small elliptical tan to brown spots expanding into very long streaks that usually have tapered, pointed ends. Fungal reproductive structures, called pycnidia, may develop within the lesions and look like black dots and release two-celled spores on the surface. The fungus survives in infested plant residue, in the soil, or on seed. Infection and disease development is favored by warm, wet conditions. Disease primarily occurs on the leaves and is related to the fungus causing Diplodia (Stenocarpella) ear rot. Because the fungus primarily survives in infested residue, the most effective management strategies in other states have been crop rotation and tillage as resistant hybrids are not available. The disease has been largely considered a minor disease in other states where it occurs now.

Holcus Spot

In 2017, some producers were surprised to see more Holcus (bacterial) spot, than in previous years. Symptom distribution in the field and on the plants themselves can help to differentiate this disease from others or from pesticide drift. Development of more disease, bacterial or fungal, in the lower leaves is common, but eyespot lesions are often much smaller, only about 1/8 inch. Holcus spot lesions are white to tan and usually ½ - ¾ inch. Herbicide drift is usually on one side of the field and appears suddenly, not spreading.

Stalk Rot Diseases and Lodging

Harvesting the 2017 corn crop was very difficult for many Nebraska producers dealing with downed corn. During the early fall, some stalk rot diseases were detected in some parts of the state that had prematurely killed some corn plants and possibly led to some yield loss. However, as harvest began, those areas affected by stalk rot were not common and overall standability was very good. However, heavy rainfall events and prolonged wet conditions began that delayed harvest in some areas for as much as four weeks. The prolonged wet conditions favored many of the existing stalk rot pathogens and other common (mostly beneficial) fungi that occur naturally in our agricultural fields. These fungi perform beneficial functions of breaking down crop residue to recycle nutrients in our soil. Some of these fungi are the same ones creating large amounts of black spores on the surfaces of senesced corn plants in the fall that release black clouds that may look like smoke from combines as they harvest. Unfortunately, the delayed harvest allowed more time for degradation of stalks by all of these microorganisms that severely compromised stalk integrity. The prolonged wet conditions that significantly delayed harvest was also followed soon by very high wind events statewide that led to the lodging of many acres of corn with weakened, vulnerable stalks. Some of these conditions are unavoidable and couldn't have been prevented. However, selecting hybrids with very good resistance to stalk rot diseases and good standability may help reduce some of these losses. Our research at the South Central Ag Lab near Clay Center, NE has also consistently shown improved standability following timely foliar fungicide applications around VT/full tassel emergence states. However, by late season if harvest is delayed significantly by adverse conditions, the benefits of fungicide application and those of disease-resistant hybrids may be negligible.

Soybean Disease Update

Loren J. Giesler, Extension Plant Pathologist

In 2017 there was an array of weather conditions leading to several soybean diseases showing up. Excessive early season moisture and heavy rains during the season resulted in many fields being affected by Pythium and Phytophthora. Yet another year with cool conditions during flowering resulted in white mold being a common problem in the northern half of the state (4^{th} year of significant effects). Sudden death syndrome was also present in several fields. Frogeye leaf spot continues to build in the state and more fields are being affected. Additional information on disease identification can be found at the UNL Crop Watch website.

Early Season Seedling Diseases

There are several pathogens involved in damping off seedling diseases. The most common in Nebraska are Fusarium, Phytophthora, Pythium, and Rhizoctonia. All four are capable of killing the developing soybean seedling or causing damage that affects the ability of the plant to achieve its full yield potential. In 2017, Pythium was the most common seedling disease problem due to cooler soil temperatures.

Criteria for assessing the use of seed treatment fungicides to manage seedling disease problems: (If these conditions are part of your production system your risk is greater.)

- History of a stand problem
- No-till
- Early planting date when soils are cool
- Poor seed quality

Phytophthora Root and Stem Rot (*Phytophthora sojae*)

Phytophthora root and stem rot of soybean is caused by a soilborne fungus that is present in many Nebraska soybean fields. The pathogen survives primarily as “resting” spores in the soil or in association with infested crop debris. Disease development is favored at soil temperatures of 60ºF and high soil moisture. We have observed in the past that dry conditions followed by heavy rain events can result in higher amounts of Phytophthora. This is most likely due to the plants being slightly stressed and the higher soil temperature. It is most common in low areas of a field, in poorly drained or compacted soils, and in soils with high clay content, although it is not limited only to these sites or conditions. It may also occur on well-drained hillsides during wet growing seasons.

Symptoms

Symptoms associated with *Phytophthora sojae* infections include seed rots, pre- and post-emergence damping off of seedlings, and stem rot of plants at various growth stages. The stem rot phase is easily identified by the dark brown color on the exterior surface of the stem and lower branches. Discoloration of the stem extends from below the soil to 6 inches or more above the soil line. The taproot turns dark brown and the entire root system may be rotted. Leaves on older infected plants become chlorotic between the veins followed by general wilting and death. Leaves will remain attached.

Management of Phytophthora Root and Stem Rot

- *Genetic Resistance*. Using resistant varieties. A combination of good partial resistance and an Rps gene are recommended. Partial resistance alone will not be as effective during early growth stages or under high disease pressure
- *Cultural Practices*. Anything which can be done to improve soil drainage
- *Seed Treatment Fungicide application.* Seed treatment fungicides containing mefenoxam or metalaxyl should be used

Sudden Death Syndrome
(*Fusarium virguliforme* syn. *Fusarium solani* f. sp. *glycines)*

The sudden death syndrome (SDS) pathogen is spread with soil; thus, the methods used to prevent soybean cyst nematode spread are also applicable to preventing spread of SDS. For symptoms to develop there needs to be high soil moisture available at flowering. As this is a soilborne disease, it will not spread rapidly across the field from individual spots that show up. Infected areas in a field can also have an oblong distribution in the direction of tillage or equipment traffic.

Symptoms
The first symptoms of SDS appear as scattered yellow or white spots on the leaves in the upper portion of the canopy. In the intermediate stage, these spots eventually coalesce to form brown streaks between the veins (interveinal necrosis). On these leaves only the midvein and major lateral veins remain green. As the disease reaches the more advanced stages, premature defoliation occurs with petioles (leaf stems) remaining on the plant. The progression from early symptoms to defoliation will occur rapidly (less than 14 days in most cases). Symptoms of SDS can be confused with brown stem rot symptoms. To differentiate the two, split the stems of infected plants and check for discoloration. If the pith (center stem) is discolored, this is a symptom of brown stem rot. Stem discoloration will be confined to the outer stem layers (vascular tissue) with SDS and can extend up the stem of infected plants.

Management of Sudden Death Syndrome
- *Resistance*. Varieties will vary in their susceptibility
- *Cultural Practices*. Avoid early planting as it favors SDS infection with cool soil temperatures
- *Fungicide application.* Seed treatment can help if the field is severely affected

Sclerotinia Stem Rot (White Mold)
(*Sclerotinia sclerotiorum*)

Sclerotinia stem rot, also referred to as white mold, is caused by a fungal pathogen that can reside in soybean fields an indefinite amount of time. 2017 was the fourth year in a row that white mold has shown up due to cool conditions during flowering. Saturated soils and a full canopy favor the emergence of apothecia from the sclerotia, which are mushroom-like bodies that produce millions of airborne spores almost daily over a 7- to 10-day period. These spores are released during favorable weather conditions and can travel to other fields in air currents.

Spores infect plants like soybean primarily through colonized blossoms that are senescing, but they can also infect through injured plant tissue. Free moisture must be present on the plant surface for infection to occur. Flowers on the tips of small pods provide a common entrance for the fungus. Invasion of the pod and eventually the stem may lead to lesions covered with sclerotia. During harvest these survival structures are scattered back onto the soil. Thus, inoculum for the next three or more seasons has been distributed.

Symptoms
Initial symptoms are visible during pod development. Leaves will wilt and turn gray-green before turning brown, curling, and dying. It is important to observe stems and pods for white mycelium and sclerotia to differentiate Sclerotinia stem rot from other stem and root rot diseases. Since blossoms are infected first, early stem or pod water-soaked symptoms often initiate near colonized flowers. In a few days diseased stem areas are killed, become tan, and eventually bleached. This bleached stem will have a pithy texture and will shred easily. Infected plant parts generally will have signs of the fungal pathogen as white, fluffy mycelium during humid conditions and sclerotia on the surface of, or embedded in the stem tissue. Although stem and pod infection usually occurs about 6 to 14 inches above the soil line, some basal infection also may be found. Infections will occur after flowering has initiated in the crop.

Management of Sclerotinia Stem Rot

- *Resistance.* Soybean varieties vary in their response to Sclerotinia but this will not fully remedy the situation.
- *Cultural Practices.* Row spacing has been shown to influence this disease, with narrow rows resulting in more Sclerotinia stem rot. Avoid irrigation during flowering. Utilizing a longer rotation with corn and wheat has been shown to reduce pathogen buildup and disease risk.
- *Fungicide application.* Foliar fungicide applications at the R1 growth stage (beginning bloom) have been shown to provide better control than applications at R3 (beginning pod).

Frogeye Leaf Spot (*Cercospora sojina*)

Frogeye leaf spot is a fungal disease that is becoming more common in Nebraska. Yield loss estimates due to frogeye leaf spot have been reported as high as 30% nationally with extensive leaf blighting, but for Nebraska I would estimate less than 20% in highly susceptible varieties. The disease is most severe when soybean is grown continuously in the same field, particularly in fields where tillage is reduced, since this is a residue-borne disease. The primary source for this disease is infested residue, infected seed, and airborne spores. In areas where this disease has been observed in past years it will typically show up again if weather conditions are favorable.

Symptoms

Infection can occur at any stage of soybean development, but most often occurs after flowering and is typically in the upper canopy. Initial symptoms are small, dark spots on the leaves. Spots eventually enlarge to a diameter of about ¼ inch and the centers of the lesions become gray to brown and have a reddish purple margin. Individual leaf spots can coalesce to create irregular patterns of blighting on the leaf. In addition, stems and pods can also be affected. Stem infections appear later in the season and will be long, narrow, dark lesions with flattened centers. Pod lesions will be circular to elongate, slightly sunken and reddish brown in color.

Management of Frogeye Leaf Spot

- *Resistance.* Soybean varieties vary in their resistance to Frogeye leaf spot.
- *Cultural Practices*. More severe in continuously cropped soybean fields.
- ***Fungicide application.*** Application of fungicides to manage frogeye leaf spot in Nebraska is typically not warranted in most fields. Fields with a history of frogeye should be watched carefully and if disease develops application of a strobilurin fungicide at the R3 (pod set) – early R4 growth.

Root and Soilborne Diseases Update

Anthony O. Adesemoye, Nebraska Extension Plant Pathologist

Planting of fungicide treated seeds have been doing a good job, helping to reduce the impacts of soilborne and root diseases. However, our survey in 2017 revealed widespread soilborne diseases in many crop hosts and many field locations in the state. The crops include corn, dry bean, soybean, and wheat. The symptoms and observation in such fields included patches of blank areas without plants, stunted plants, discoloration, wilting and drying of plants, and reduced stand population. Diseases were more common in areas with low elevation in the field. This update is provided on four soilborne pathogens - *Rhizoctonia, Fusarium*, *Phytophthora*, and *Cephalosporium*.

Rhizoctonia root rot

Plant samples showing symptoms typical of Rhizoctonia were located in many fields across the state, samples of corn, dry bean, soybean, and wheat were collected and isolates were recovered. In 2016 and 2017, a total of 144 isolates were collected, which belonged to two major groups - *R. solani* and *R. zeae*. The *R. solani* isolates collected belonged to diverse sub groups (anastomosis groups) and the most common group was *R. solani* AG-4. Previously, *R. zeae* was not considered to be a major pathogen of soybean but in the ongoing study, many recovered *R. zeae* isolates have been found to be pathogenic to soybean but also to corn and wheat. Data being generated from the study supports the need for a good strategy for integrated management of Rhizoctonia root rot diseases. The Rhizoctonia isolates are being further examined in greenhouse and field studies to understand their virulence and the effect of fungicide treatment, biological control product, and environmental conditions on disease development and management. Substantially reduced stand population of soybean was observed when seeds without fungicide seed treatment was planted in a field study with *Rhizoctonia solani* (Figure 1).

Figure 1. Reduced stand population and stunting caused by *Rhizoctonia solani* to plants without fungicide seed treatment (right) compared to those with fungicide seed treatment (left).

Fusarium root rot

In 2017, a survey of Fusarium diseases in corn, soybean, and wheat fields was conducted and a total of 137 isolates, which belonged to 11 different *Fusarium* groups were recovered across the state from 2016 to 2017. Among the groups, *Fusarium oxysporum* and *F. graminearum* were the two most widely distributed and virulent across Nebraska and they present the highest risks of Fusarium root rot in corn, soybean, and wheat crops. Greenhouse tests on the pathogenicity of isolates showed that close to half (42%) of all the isolates tested were cross-pathogenic to the three crops. This indicates that the same strains that caused disease in corn are able to cause disease in soybean as well as wheat. In a field where such isolates of Fusarium were present, crop rotation to manage the disease will be less effective.

Phytophthora root and stem rot diseases

Phytophthora disease is favored by warm and wet weather and saturated conditions, especially in poorly drained clay or compacted soils. Patches resulting from killed seeds after planting or after seedling emergence were seen in certain fields in 2017. Although it is more common early in the growing season, it may also damage plants throughout the growing season. Symptoms of the disease include rotted root, stunting, and yellowing of leaves in tolerant varieties while in susceptible varieties, additional symptoms include soft stem, plants death, and browning of leaves or wilted leaves that remained attached after plant death.

Cephalosporium stripe

Cephalosporium stripe in wheat is caused by *Cephalosporium gramineum*. The incidence of this disease was high in 2017 as it has been increasing in Nebraska in the last three years. The conditions in spring 2017 was conducive for the disease as infection is favored by cool, 45 to 55°F, and moist conditions. One to three longitudinal yellowish stripe running through the leafsheat and cum of a maturing green leaf is the diagnostic symptom of the disease. During jointing and heading, the yellow stripe will become very prominent. It was more severe in wheat fields that follow wheat or other susceptible cereal or grasses such as oat, barley, rye, triticale, and grasses such as downy (cheatgrass) brome. In 2017, Cephalosporium stripe was more prevalent in low, wet areas of the field and acid soils. In most of the fields, the symptoms occurred on the lower leaves.

Figure 2. Cephalosporium stripe symptoms on wheat leaves in the field with prominent yellow color in Lincoln County, Nebraska on May 25, 2017.

Management of Root and Soilborne Diseases

The following strategies are recommended for management of the diseases.

(1) Planting of fungicide treated seeds is very important to manage these diseases except Cephalosporium stripe.

(2) Increase drainage, if possible, to reduce soil saturation, especially for *Phytophthora* diseases.

(3) Crop rotation is very useful but effectiveness may reduce when pathogens are cross-pathogenic to rotation crops.

(4) Plant resistant varieties when available.

(5) Timing of planting e.g., seeding 10 days later can significantly reduce Cephalosporium stripe.

(6) Use of biological control products.

(7) Integrated disease management that combines multiple or all of these strategies.

What's New in Plant Pathology

Tamra Jackson-Ziems, Nebraska Extension Plan Pathologist
Kyle Broderick, Coordinator, Plant & Pest Diagnostic Clinic

Changes in the Plant & Pest Diagnostic Clinic

Plant Pathology Welcomes a New Team Member

On April 1, 2017, Kyle Broderick became coordinator of the Plant & Pest Diagnostic Clinic after working as an extension technologist in a University of Nebraska soybean pathology lab for six years. His research focused on management of soybean cyst nematode using resistant varieties and seed treatments and conveying the information to the public through field days and demonstration sites. Additionally, he was involved in seedling disease surveys.

Kyle grew up on a small farm near Seward, Nebraska; though both of his parents were teachers, growing up around commercial agriculture helped foster a passion for plant sciences. He received his bachelor's degree in plant protection sciences and master's in agronomy (plant pathology) from the University of Nebraska-Lincoln.

Knowing one's enemy is the first step towards beating it. With plant pathology accurate diagnosis allows us to know what's causing the disease and guides proper management. Kyle looks forward to working with industry professionals, growers, and the general public across the state of Nebraska to properly manage diseases in agronomic, horticultural, and landscape plants.

Services Provided

The P&PDC is set up to diagnose diseases caused by both living (fungi, bacteria nematodes, viruses) and non-living factors (environmental stress, nutrient deficiencies, etc.), identify insects, mites, or other arthropod pests, and identify unknown weeds. Herbicide injury is determined solely on a visual inspection and no chemical analysis performed. The clinic is not able to provide soil nutrient testing nor pesticide residue analysis.

Sample Fees

Basic diagnosis costs $15. If specialized tests are required, additional fees are assessed that typically range $10 to $40.

Diplodia Leaf Streak

In 2017, Diplodia (Stenocarpella) leaf streak, caused by the fungus Stenocarpella macrospora (syn. Diplodia macrospora and S. zeae) was confirmed in samples from eastern Nebraska. This fungal disease has been previously identified in several additional states in the U.S. The large tan lesions caused by Diplodia leaf streak may look similar to the large lesions of northern corn leaf blight or Goss's bacterial wilt and blight. Because the fungus primarily survives in infested residue, the most effective management strategies in other states have been crop rotation and tillage as resistant hybrids are not available. More information will be presented and available in the Corn Disease Update.

New and Updated Product Labels for Disease Management

The Disease Management Section of the 2018 Guide for Weed, Disease, and Insect Management in Nebraska underwent a few changes this year. In addition to minor formatting changes, updated price estimates, and annual updates to the Efficacy Tables, several new products were added, as well as a couple of modes of action. New modes of action and products are listed below in Tables 1-4.

Table 1. Modes of Action added to the 2018 Guide for Weed, Disease, and Insect Management in Nebraska.

FRAC Code	Code Number	Mode/Site of Action	Common Name/Chemical Group
Group 29	C5 uncouplers of oxidative phosphorylation	Respiration	Fluazinam/2,6-dinitroanilines
Group 49 (previously Group U15)	Oxysterol binding protein homologue inhibition (OSBPI)	Lipid synthesis or transport/membrane integrity or function/F9 lipid homeostasis and transfer/storage	Oxathiapiprolin/piperidinyl-thiazole-isoxazolines

Table 2. Foliar products for disease control that were updated in the 2018 Guide for Weed, Disease, and Insect Management in Nebraska.

Trade Name	Active Ingredient(s)	Fungicide Class	Change(s) Made
Delaro	Prothioconazole (16.0%) + Trifloxystrobin (13.7%)	Mixed Modes of Action (Groups 3 + 11)	Added to Corn, Sugar Beet, table
Nexicor	Fluxapyroxad (2.81%) + Pyraclostrobin (18.76%) + Propiconazole (11.73%)	Mixed Modes of Action (Groups 3 + 7 + 11)	Added to Sorghum and Wheat tables
Topguard EQ	Azoxystrobin (25.3%) + Flutriafol (18.6%)	Mixed Modes of Action (Groups 3 + 11)	Added to Corn, Sorghum, Soybean, and Wheat tables
Trivapro	Azoxystrobin (10.5%) + Benzovindiflupyr (2.9%) + Propiconazole (11.9%)	Mixed Modes of Action (Groups 3 + 7+ 11)	Added to Corn, Soybean, and Wheat tables

Table 3. Seed treatment products for disease control that were updated in the 2018 Guide for Weed, Disease, and Insect Management in Nebraska.

Trade Name	Active Ingredient(s)	Fungicide Class	Change(s) Made
Lumisena	Oxathiapiprolin (18.7%)	OSBPI Oxysterol binding protein homologue inhibition (Groups 49)	Added to Soybean table
Omega 500F	Fluazinam (40.0%)	2,6-dinitro-anilines (Group 29)	Added to Soybean table

Table 4. Nematicides added to the 2018 Guide for Weed, Disease, and Insect Management in Nebraska.

Trade Name	Active Ingredient(s)	Function	Registered Crops
Acceleron NemaStrike	Tioxazafen	Nematicide	Corn (field), Soybean
ILeVO[1]	Fluopyram (48.4%)	Nematicide	Soybean

[1]ILeVO was previously added to the table, “Soybean: Seed Treatment Fungicide Product Information” In: 2017 Guide for Weed, Disease, and Insect Management in Nebraska.

Fungicides are for Fungi

Loren J. Giesler, Robert M. Harveson, Tamra A. Jackson-Ziems, and Stephen N. Wegulo
Extension Plant Pathologists

Management of foliar fungal disease is achieved by the application of fungicides in many of our field crops. Over the past several years, there have been examples of misidentification of some bacterial diseases in field crops that are easily confused for fungal diseases. This article reviews some of the common mistakes made in the major field crops as well as reviews some research on the impact of fungicide use after hail events in corn and soybean. This article has been condensed to meet formatting requirements. Additional information will be presented and included in the online full-length proceedings article.

- Comparison of identification of fungal diseases and common bacterial diseases that can be confused in Nebraska field crops.
- Effects of fungicides after hail injury: research data summary.
- Factors affecting overall fungicide activity on late season crop health.
- Fungicide effects on yield in the absence of disease vs in the presence of fungal diseases

Corn

Bacterial Leaf Streak vs. Gray Leaf Spot

Bacterial leaf streak can appear very similar to the common fungal disease, gray leaf spot. Misdiagnoses have led to fungicide treatment of bacterial leaf streak that won't control the pathogen. Look closely at lesions for wavy, jagged edges indicative of bacterial leaf streak versus the smooth rectangular lesions of gray leaf spot. Bacterial leaf streak may also appear bright yellow when backlit and develop during the early growing season, in contrast to gray leaf spot.

Goss's Bacterial Wilt and Blight vs Northern Corn Leaf Blight

Goss's bacterial wilt and blight was more common in 2017 than in recent years. Lesions often have small, dark "freckles" and a water-soaked appearance on the edges. In contrast, fungal diseases, such as northern corn leaf blight and Diplodia (Stenocarpella) leaf streak can also produce large lesions, but lack the water-soaked appearance common in bacterial diseases. Northern corn leaf blight commonly has lesions with rounded ends versus Diplodia leaf streak that often causes lesions with pointed ends

Dry Beans

Rust vs Sunburn

Rust is an important disease that affects dry beans in Nebraska, Colorado, and adjacent regions in the Central High Plains. The disease is caused by the obligate fungus *Uromyces appendiculatus* and has caused sporadic epidemics in this region for more than 50 years. Yield losses from the disease have been documented to exceed 50 percent, and a timely fungicide application will generally be effective in limiting yield reductions.

However, and abiotic condition has been noted in recent years that could easily be confused with rust. Leaves, stems and pods affected by sunburn can be look very much like rust from a distance, thus correct identification is critical in order to make a proper management decision. A misapplied fungicide will not affect the sunburn condition and will be economically damaging for the unneeded chemical and application costs. Rust will leave a powdery substance on fingers after touching symptomatic tissues and the sunburn will not.

Sugar beet

Cercospora leaf spot vs bacterial leaf spot

Cercospora leaf spot (CLS) is the most serious and destructive foliar disease of sugar beets in the Central High Plains of western Nebraska, northeastern Colorado, and southeastern Wyoming. This disease is caused by the airborne fungus *Cercospora beticola*. Individual lesions are approximately 1/8 inch in diameter with ash-colored centers and purple to brown borders, and are circular to oval shaped. Cercospora leaf spot is distinguished from other leaf diseases (Alternaria, Phoma and bacterial leaf spots) by their smaller size and shape and the presence of black spore-bearing structures, called pseudostromata, that form in the center of the lesions. These structures are easily seen as black dots with the aid of a hand lens (10 X Magnification).

Correctly identifying CLS is also critical for making the most economical management decisions. It is important to distinguish it from bacterial leaf spot because the use of a fungicide would not reduce disease caused by bacterial leaf spot. Furthermore, CLS is the only foliar disease that is potentially damaging enough to need to treat. Other fungal leaf spots diseases like Phoma and Alternaria do not generally cause enough damage to require fungicide treatments. Therefore the confusion of CLS with other disease could not only be problematic by unnecessarily applying a fungicide, but if a fungicide is not applied when CLS is present, producers would potentially lose either way.

Wheat

Bacterial Streak vs. Septoria Tritici Blotch

Bacterial streak (black chaff when it occurs on heads), caused by *Xanthomonas campestris* pv. *undulosa*, can be confused with Septoria tritici blotch caused by *Zymoseptoria tritici*. Lesions caused by both pathogens can enlarge into large brown necrotic areas or blotches on leaves that can be difficult to distinguish. Bacterial streak lesions are most conspicuous after heading, when many lesions can appear suddenly on the upper leaves without evidence of progression from lower leaves. They are irregularly shaped and elongate and may extend the length of the leaf blade. When conditions are moist, bacteria ooze from the lesions and later the exudate dries to form thin flakes that are almost transparent and can be seen when the leaf is viewed at different angles. In contrast to bacterial streak, Septoria tritici blotch lesions appear early in the spring on the lower leaves of seedlings that emerged the previous fall. On these seedlings, the lesions are oval with a tan center surrounded by a yellow halo. Asexual fruiting structures known as pycnidia usually will appear in these lesions as tiny black specks. Under wet conditions during stem elongation and heading, lesions appear progressively from the lower to the upper leaves. On the upper leaves, the sides of the lesions tend to be straight without a distinct yellow halo. The lesions may coalesce, resulting in large necrotic areas that in the absence of pycnidia can be indistinguishable from those caused by bacterial streak.

Crop Residue and High-Carbon Char: Potential Soil Conservation Tools

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Soil is the single most important resource on which our agriculture depends. Proper soil management is necessary to sustain long-term agricultural productivity. Soil loss through erosion or run-off hurts agricultural production with depletion of organic matter and fertility. It also has environmental implications. Much progress has been made to reduce soil erosion per unit of production in the U.S. corn and soybean production (Fig. 1) although progress appears to have slowed since 2005 (GAP Report, 2017). Reduced and no-till practices have declined from 25 % to 19 % and 21 % respectively since 2005, with a corresponding increase of conventional tillage to about 60 % (Field to Market, 2016). This trend, combined with more highly erodible land from the Cropland Reserve Program coming back into production over the same time period, has contributed to the slow progress in soil conservation. Between 1980 and 2015, corn and soybean yields in the U.S. improved by 61 and 29%, respectively, with corresponding decline in soil erosion by 58 and 47%.

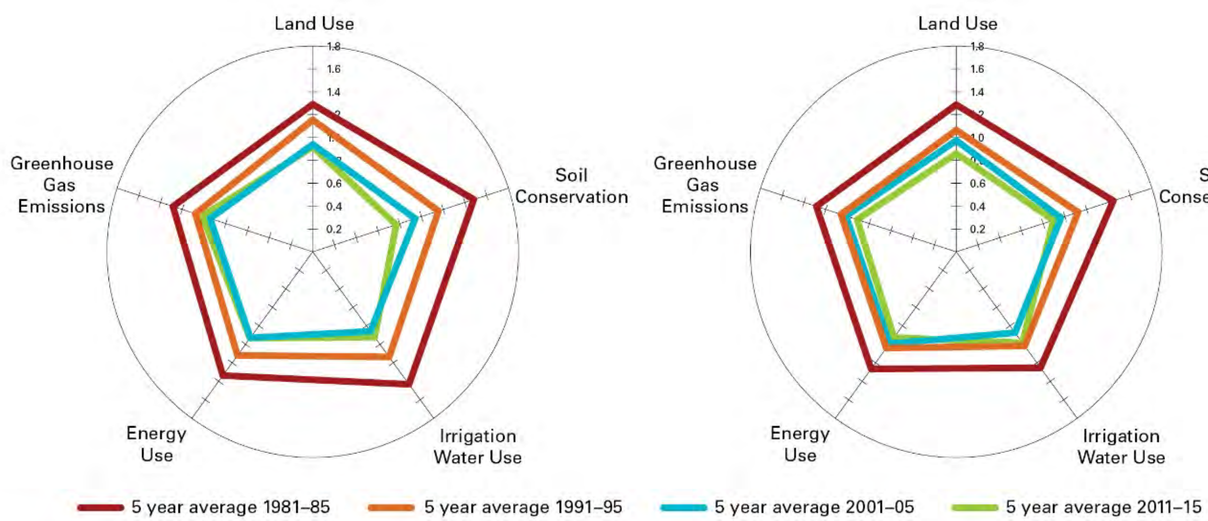

Figure 1. Index of resource use to produce corn (left) and soybean (right), U.S., 1980-2015. Data are presented in index form, where the year 2000 (average of 1996-2000) =1 and a 0.1 point change is equal to a 10 percent difference. Year 2000 value for soil conservation is 4.7 tons per acre. For full 2017 Global Agricultural Productivity Report, please visit http://www.globalharvestinitiative.org/gap-report-gap-index/2017-gap-report/

Soil erosion includes water and wind driven erosion. Soil conservation practices are tools to prevent soil loss and degradation and build soil structure and organic matter. Depending on site-specific conditions, these practices may include, but are not limited to:

- physical barriers such as terraces (including terrace segments, tile outlet terraces, etc.)
- crop rotation
- reduced tillage

- cover cropping
- mulching
- standing crop residue for wind erosion
- ground cover by crop residue for water erosion control
- contour farming
- maintenance of high soil organic matter and soil aggregation
- adding soil amendments

In Nebraska, where there is a distinctive gradient in precipitation across the state, the same practice might not be effective everywhere. Nutrient and pest management are a few other factors that also play a role in conserving soil.

Nebraska Management Options and Research for Soil Conservation:
Below we focus on crop residue management and amendment for soil conservation.

Residue management and its effects on soil
The value of leaving crop residue as ground cover to reduce water and wind erosion and slow runoff is well known. However, crop residue is a valuable livestock forage in Nebraska and removing of crop residue from no-till land can be important for high yield production. Soil organic matter is maintained by decomposition of plant biomass that remains in the field, especially by the root material but also above ground material. Our best estimate of the minimum amount of residue that is needed to maintain soil organic matter is 2 or 3 ton/acre/year (2 tons of corn residue usually gives about 50 % cover). This value is just a starting point since as tillage increases (frequency, depth, degree of soil disturbance) more residue is needed to balance the increased decomposition rates that result. For example, in three counties across Nebraska, the average amount of crop residue needed to provide sufficient ground cover to limit soil loss to no more than 5 ton/acre/year was estimated using the USDA-NRCS water erosion estimator RUSLE2 (Figure 2). For more information on residue management, please refer to NebGuide G1846.

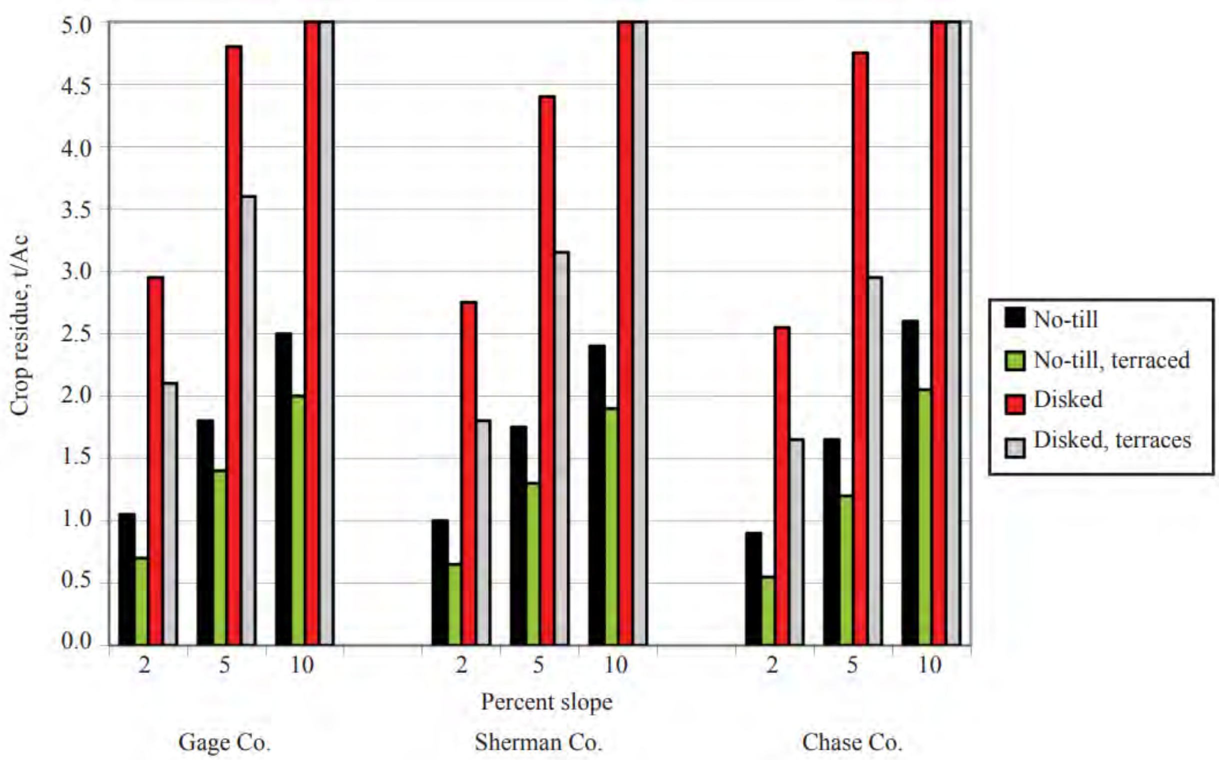

Figure 2. Crop residue needed to keep water erosion < 5 ton/acre/year for silt loam and silty clay loam soil on three slopes in the three counties of Nebraska. Bars reaching the upper limit of the chart indicate that more than 5 ton/acre of crop residue needs to remain as ground cover in the field.

Soil loss through wind erosion is especially important in semi-arid western Nebraska and worsens during drought. Ground cover with crop residue can control or minimize wind erosion. Maintaining standing crop residue is important for reducing wind velocity at the soil surface and trapping soil particles, as well as for trapping snow in winter to provide for much needed soil water in semi-arid areas. Ground covers of 30 and 60 percent are estimated to reduce wind erosion by 70 and 90 percent respectively (see NebGuide 1537). The NRCS Wind Erosion Prediction System suggested that often no crop residues can be removed under rain-fed, tilled conditions in western Nebraska.

State of the soil in semi-arid western Nebraska

In western Nebraska, crops are often grown in fields that have been leveled for irrigation, intensively farmed or have been affected by wind and water erosion, all of which can decrease soil organic matter (SOM). Lack of SOM is a significant indicator of a degraded soil. When grown on degraded soil, plants are prone to less vigorous foliar growth, chlorosis, poor root development, and poor emergence due to soil crusting. Furthermore, lighter colored soils low in organic matter warm up slower and have less potential to produce nutrients from mineralization. Many intensively cultivated soils in the Great Plains have lost 30 to 50% of the original SOM level.

Soil organic matter affects many soil physical, chemical, and biological processes and properties (UNL Extension G2283). Increased SOM reduces compaction risks and improves soil structure, water holding capacity, cation exchange capacity, and microbial activity. Soil organic matter loss can be particularly negative in coarse-textured soils like many of those in western Nebraska. Restoring SOM lost is a high priority to enhance crop production in general.

Current research with soil amendments to improve soil properties

In 2017, a field research study was initiated in the Panhandle at a low-productive field under center-pivot to assess carbon-rich char (also known as cinder), biochar from pine trees, manure and municipality waste products as potential amendment to restore the soil quality and increase dry bean production. Char is residue left after inefficient burning of coal. Biochar is charcoal produced by pyrolysis, or non-combustion 'burning without oxygen, during which C molecules are converted to more stable cyclic forms giving biochar a half-life in the soil that may exceed 100 years.

Aerial imagery early in the season showed an encouraging evidence of these products, particularly char as a potential soil amendment (Figure 3). The first year dry bean yield was significantly greater with the highest char rate (60 ton/acre) compared to the no char plots. Dry bean yield increased by 12-52 % with char application with the highest increase in the highest rate of char. This year, spring was cool and wet and there were chlorosis issues. Char might have improved aeration and/or infiltration by improving soil physical properties and that could have led to some beneficial effects. It would require at least a few years of monitoring of this field to document any other significant benefits of any of these amendments with respect to agronomic productivity or soil properties.

The soil of the char trial was calcareous, sandy loam and had ~1% SOM. The trial was in an area under center pivot that had low productivity compared to the rest of the field probably due to leveling of the field at some point of time in the past. We expect that the char will be most effective for soils that are low in SOM and degraded.

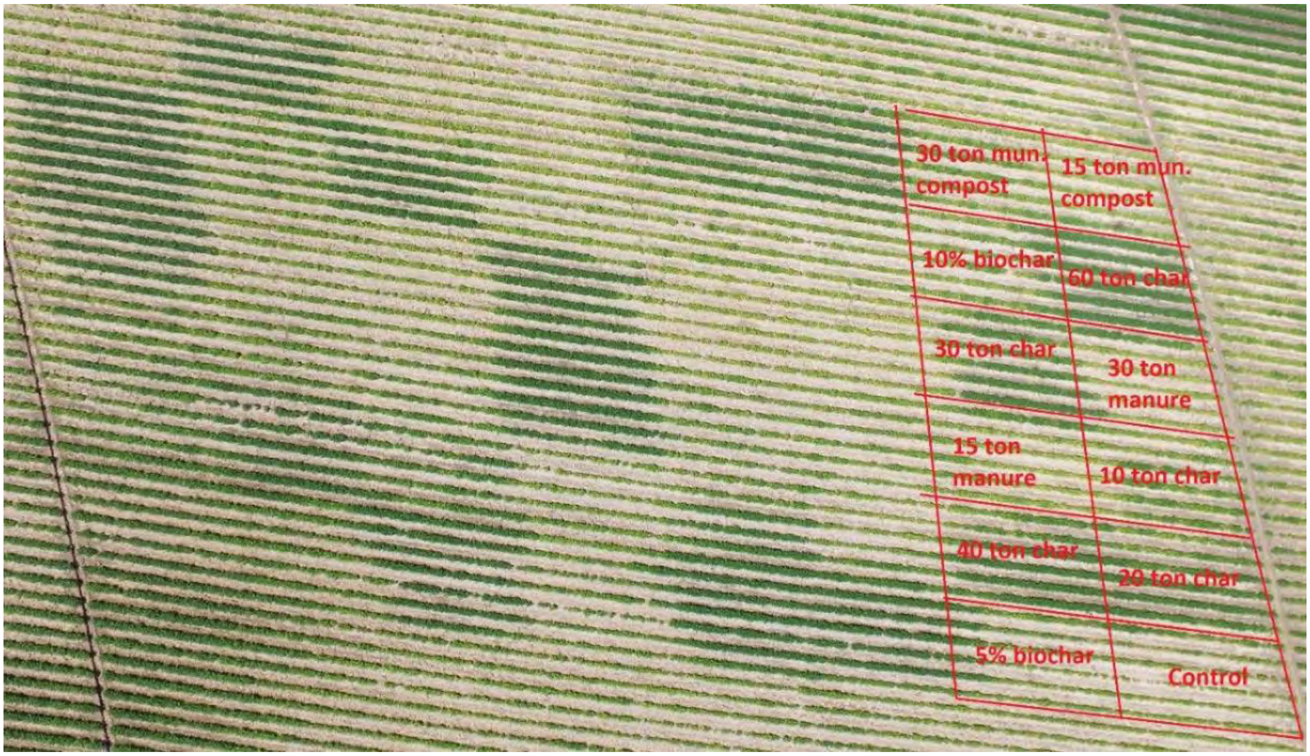

Figure 3. Aerial imagery was collected at bean emergence using a drone. All five rates of char (10, 20, 30, 40, and 60 tons/acre) were greener early in the season in all four replications (only one rep is depicted here).

Concluding remark

Soil is a finite resource in the sense that it is hard to replace. It is therefore, important for our agricultural production sustainability to conserve and preserve this invaluable resource. Considering land conditions, climatic specificity for the area, cropping system and other important factors, there are various conservation practices available. Any effort towards conservation would immensely benefit soil and agricultural production in that land for many years to come.

Improved Use Efficiency of Applied Organic Nitrogen

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Land application of organic materials for soil management in Nebraska is important.

- Organic N applied annually to Nebraska cropland is equal to 150 lb/ac N applied to about 1.3 to 1.6 million acres.
- Beef feedlot manure is important but other livestock manure, but organic municipal and industrial wastes in total are also important. We refer to all as manure in the following.
- The availability of applied organic N and the fertilizer N substitution values of applied organic materials is not well predicted (Table 1).
- The uncertainty of applied organic N availability leads to over-application of fertilizer N resulting in low efficiency of applied N use.
- Canopy sensor guided in-season N application practices have been validated for corn produced on unmanured fields and may be a way to greatly improve N use efficiency for applied organic N.
- Application of 30 to 60 lb/acre of fertilizer N pre-plant followed by in-season fertilizer N application according to crop need may greatly improve applied N recovery and use efficiency.
- The canopy sensor practices may need calibration for manured fields, possibly with variations due to manure type and years since manure was applied.

The research objectives

1) Validate or adapt canopy sensor guided in-season N application practices for fields with manure or other organic material applied.
2) Improve the prediction of the fertilizer N substitution values for organic materials

The Methods

- Two sets of trials
  - Set 1 trials were at Brule (2014-2016) and Eastern Nebraska Research and Extension Center (ENREC) (2015-2017) with 0, intermediate and high levels of composted or stockpiled feedlot manure applied. Each manure level had a set of N ramp treatments with 27 lb/acre N rate increments to 107 lb/ac, and a high N reference strip of 178 lb/ac, applied before planting.
  - Set 2 trials were at 6 locations in eastern Nebraska with 8 different organic materials during 2016 and 2017 (Table 2). No pre-plant fertilizer N was applied to the organic material treatments.
- The crop was continuous corn with no tillage
- Crop canopy reflectance was sensed for NDRE (Normalized Difference Red Edge Index) at V12 to v14 and plots were split for with and without sensor guided in-season N application.
- The algorithm for interpretation of sensor readings was: in-season N rate = 317 $\sqrt{0.97 - SI}$

where SI= $\frac{\text{NDRE}}{\text{NDRE (Non limiting plot=200 kg/ha N)}}$

- Grain yield and other variables were measured.

Results I. Crop canopy sensor guided in-season N application for manured fields.

- The in-season N rate at ENREC was 43% and 17% less with manure applied compared with no manure for the year of application and for the mean of the 2nd and 3rd year after application, respectively. The in-season N rate was 23% less with manure applied at Brule.
- The sufficiency index algorithm over-estimated N need when the pre-plant N rate was 0 or 27 lb/acre (30 kg/ha) (Fig. 1).
- Yield potential was lost if the crop was too stressed by low pre-plant N application.
- Pre-plant N of 55 lb/acre prevented excessive low N stress while allowing for NDRE differences expressive of crop N need and determination of in-season N application rates.
- The best time for canopy reflectance sensing was determined to between V12 and V14.
- The above SI algorithm worked well (Fig. 1). Data analysis has not yet finalized improvements to the algorithm either for manured or unmanured fields.
- In a preliminary comparison of the above algorithm with another used in Nebraska, the latter tended to under-apply in-season N. This needs further data analysis.

Results II. Improve the prediction of the fertilizer N substitution values for organic materials.

- Similar for rainfed and irrigated
- 77% greater for a loamy sand compared with silt loam and silty clay loam soils
- Not affected by C:N ratio for these materials but a big effect of cellulose and lignin contents so that N substitution was 2.3 times more for livestock manure compared with municipal biosolid
- Not reduced by composting compared to uncomposted.

Compared with previous estimates of FNS (Table 1, 2)

- FNS was 28% higher for cattle manure
- FNS was 67% higher for compost.

Table 1. Current recommendation of estimated first-season availability (%) of manure organic-N.

Source	% organic-N available in first year[1]		
	Solid	Fresh liquid	Stored liquid
Beef/dairy	25%	-	35%
Poultry	30%	-	-
Swine	-	50%	35%
Compost	15%[2]		

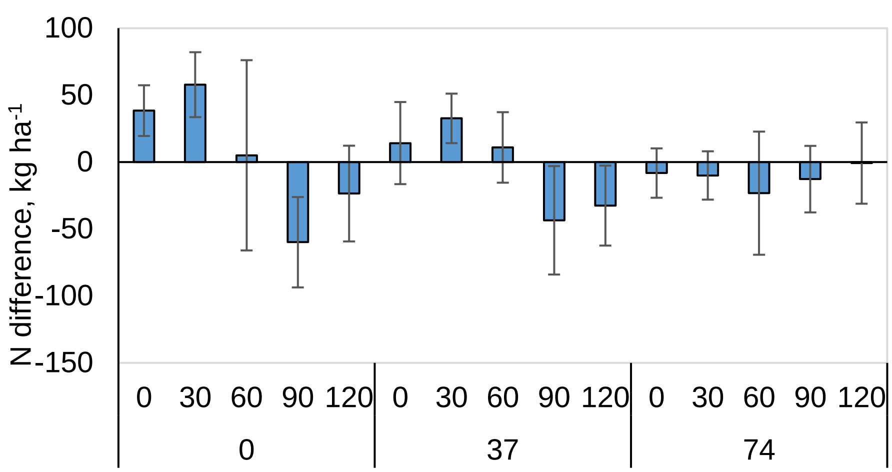
1 Assumes spring-seeded crops; for fall-seeded crops, multiply values by 70% to account for delayed mineralization during cooler months

2 This estimate is for composted feedlot manure but composts of lower C to N ratios are expected to have higher availability.

Table 2. The organic materials used in the research, their C:N ratio and acid detergent fiber (ADF) values, and their apparent organic N recovery (AONR) and fertilizer N substitution value (FNS; lb fertilizer N per lb of applied organic N) for the corn crop that followed application.

Organic material	C:N	ADF	AONR	FNS
Stockpiled feedlot manure	10.3	226	0.27	0.32
Feedlot scraping	11.8	205	0.25	0.29
Turkey manure	9.5	211	0.28	0.33
Dairy manure compost	8.7	285	0.30	0.34
Novozyme bio-product	6.0	84	0.24	0.28
Lincoln municipal biosolid	7.1	387	0.13	0.15
Fremont biosolid composted	9.7	440	0.13	0.15
Fremont biosolid dewatered	8.3	378	0.10	0.11

Figure 1. Difference between N needed for the achieved yield and that applied for three manure rates, each with 5 N levels at ENREC in 2015. Pre-plant N rate, 0 to 120 kg/ha; Manure rate, 0, 37, 74 t/ha.



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Feasibility of Sensor Based Nitrogen Fertigation Management in Corn

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Averaged across two years, the sensor based N fertigation treatment consistently resulted in higher profit and nitrogen use efficiency. The use of fertigation offers the unique capability to minimize N losses by reacting to slight N deficiencies in corn by applying N multiple times throughout the season with lower application rates.

Methods

- Treatments:
    - **Check** (5 lbs of N/acre as starter only)
    - **High N Reference** (non-N limiting treatment)
    - **UNL algorithm** (current N rate BMP, one time in-season sidedress informed by yield goal and N credits)
    - **Holland-Schepers (H-S)** (sensor-BMP similar to Project SENSE, one time in-season sidedress directed by sensors) (Holland and Schepers, 2010)
    - **Reactive-fixed fertigation** (fertigation directed by sensors: react to deficiency, N rate fertigated is fixed)
    - **Reactive-model fertigation** (fertigation directed by sensors: react to deficiency, N rate fertigated is determined by crop computer model)
    - **Slow release reactive-model fertigation** (initial N applied as polymer coated urea (slow release), fertigation directed by sensors: react to deficiency, N rate fertigated is determined by crop computer model)
    - **Model-fertigation** (not sensor informed, proactive N management is informed by crop model)
- All but Check received an initial base rate of N to maintain N sufficiency until sensors become reliably effective at V8
- N was applied as UAN with exception of the slow release treatment that received slow release nitrogen as the initial base rate.
- Sensor based methods use sufficiency index (SI) to indicate level of N stress.
- Research conducted in 2016 and 2017 at location South Central Ag Lab near Clay Center, NE under sprinkler irrigation/fertigation

Results

- Reactive-fixed fertigation treatment grain yield was not significantly different from that of the High N reference, but used considerably less nitrogen in both site years.
- The one time in-season sidedress application treatments (UNL, H-S) recommended more N compared to reactive-fixed fertigation treatment, but no accompanying gain in grain yield.
- Nitrogen use efficiency (NUE) reported as partial factor productivity (PFP) was highest for the reactive fixed fertigation treatment in both site years.
- Partial profit varied slightly by year. There was no significant difference between the treatment with highest partial profit and that of the reactive fixed fertigation treatment in both site years.
- Averaged across both years, the reactive-fixed fertigation treatment consistently resulted in higher profit and nitrogen use efficiency.

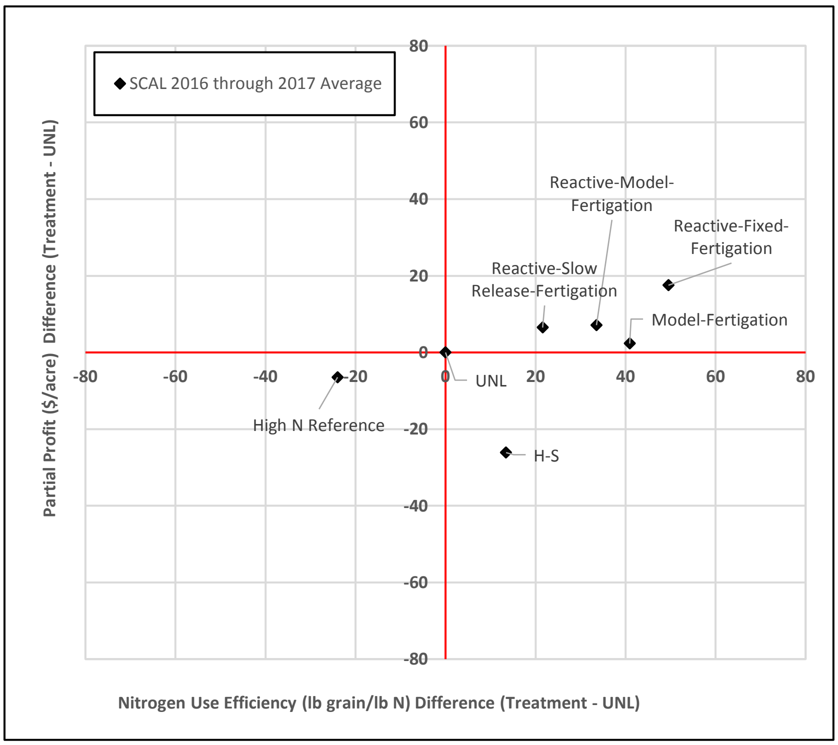


Figure 1: The chart above compares the difference of each treatment vs. the UNL treatment (Treatment – UNL) for partial profit and nitrogen use efficiency. Data for each treatment was averaged across years 2016 and 2017 for the South Central Agricultural Laboratory (SCAL) near Clay Center, NE. Partial profit was calculated using grain prices and N costs specific to each year: Partial Profit = (grain price * grain yield) – (N price * N applied). Treatments in the upper right quadrant indicate values that are more profitable and more N efficient when compared to the UNL algorithm treatment.

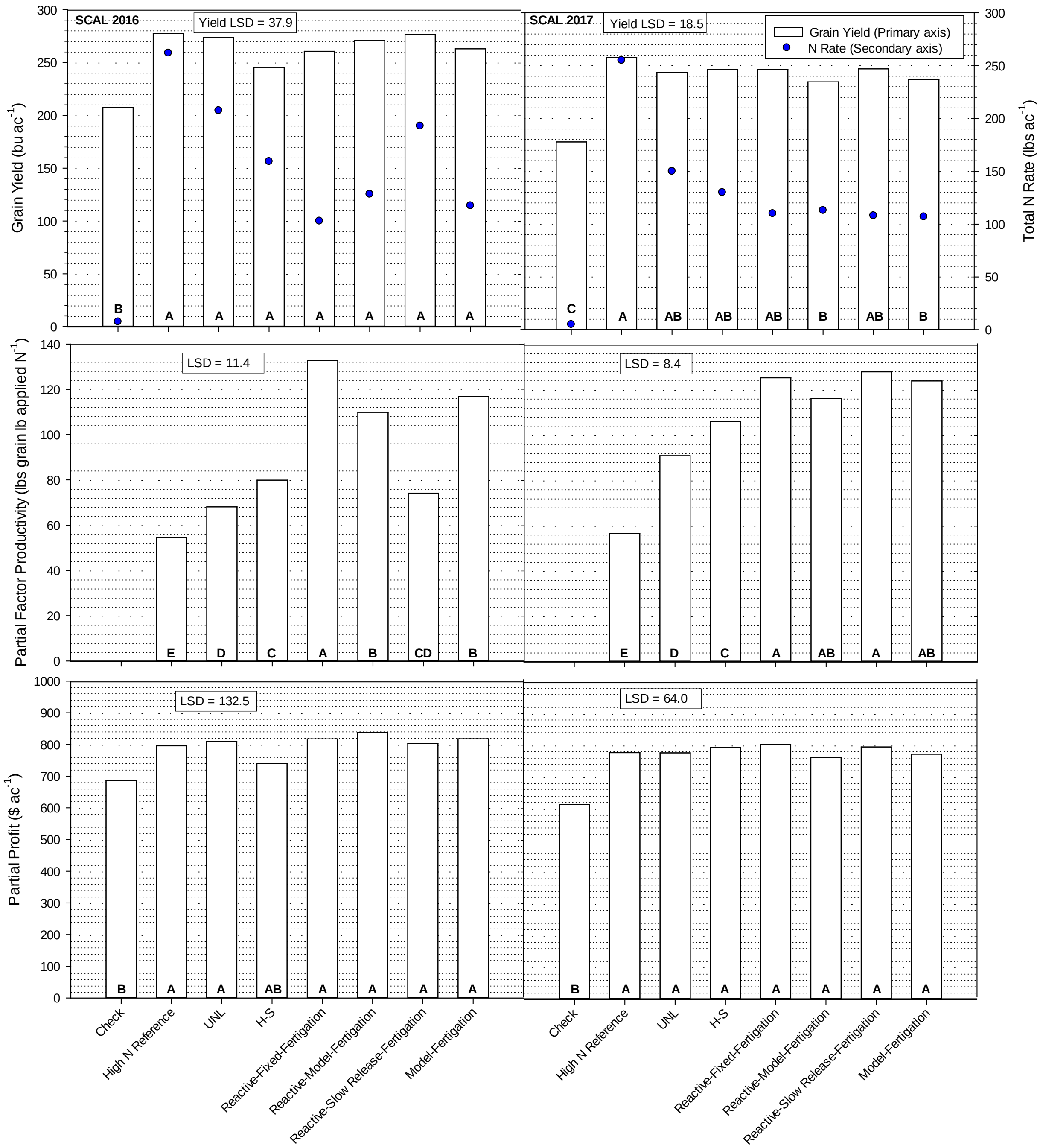


Figure 1: (Top) Grain yield and applied N rate, (Middle) partial factor productivity, a measure of nitrogen use efficiency (NUE), and (Bottom) partial profit for 2016 and 2017 at location SCAL. An alpha level of 0.05 was used for LSD mean comparison and is reported on each respective chart. Treatments with the same letter are not significantly different. Partial profit was calculated using grain prices and N costs specific to each year.

Closing/Summary

- No evidence to suggest use of 0.95 SI as the threshold for application is detrimental to yield.
- In 2016 and 2017 at location SCAL, the sensor guided reactive-fixed fertigation treatment:
    - Had the highest nitrogen use efficiency (partial factor productivity)
    - Was among the highest yielding treatments (not significantly lower than any other)
    - Had the highest partial profit
    - Sensor based fertigation shows potential to be a new BMP that increases nitrogen use efficiency while maintaining or increasing profit

North Platte River Surface Irrigation Projects and Power Generation

Gary Stone, Nebraska Extension Educator

Figure 1. Pathfinder dam and reservoir on the North Platte River in central Wyoming. One of three major reservoirs for irrigation water storage and flood control for agricultural operations along the North Platte River in eastern Wyoming and the Panhandle of Nebraska. Gary Stone photo.

Irrigation is needed in much of the Nebraska Panhandle to produce good crop yields. Growers along the North Platte River valley rely on surface irrigation water from reservoirs in Wyoming to supply this water.

A brief history of the North Platte River dams and reservoirs

- When these were constructed
- Where they are located
- What purpose and function they provide other than irrigation water
- Who manages the system
- Water term definitions

Growers and the public should be knowledgeable about the irrigation system that provide much need irrigation water for North Platte Valley crops. They should also gain a better understanding of the other uses of the water resource flowing in the North Platte River.

Economics of Variable Frequency Drives for Irrigation Pumps

Bill Kranz – Extension Irrigation Specialist

In recent years irrigators have begun to install variable frequency drives (VFDs) to monitor and control the speed of their irrigation pumps powered by electricity. This has led to several recent questions:

- Should VFD be installed on all electric motor power irrigation pumps?
- Will VFDs pay for the expense of installation?

VFDs are electronic monitor and control systems that alter the speed of pump rotation by adjusting the frequency of the electricity delivered to the motor. It turns out that the motor cares little about what frequency the power is and the speed of the motor changes linearly with the change in frequency. For example, if the standard speed of the electric motor is 1770 rpm and you wanted the motor to run at 1650 rpm, you would adjust the frequency of the electric supply from 60 hertz down to 56 hertz [1650 rpm ÷ 1770 rpm x 60 hertz],

When the pumping plant is designed for a center pivot installation, the pump impeller is selected that will deliver a desired flow rate and pressure to the highest elevation in the field with all sprinklers in operation. The final criteria is that the impeller operate at near maximum efficiency. Irrigated fields have some level of elevation change, but since the design is based on the worst case scenario most of the field will receive greater pressure and flow rate than needed. Enter VFDs.

Dilshad Brar, a graduate student in the UNL Biological Systems Engineering Department, looked at 1000 center pivot installations in 10 Nebraska counties to determine if placing a VFD on the system would be economical. A standard length center pivot with eight towers was superimposed on each field’s digital elevation map. The hydraulics of the systems were calculated for a set flow rate and diameter of pivot pipeline.

For Scenario 1 the center pivot system did not have an end gun. Despite the rolling terrain in some of the counties, use of VFDs resulted in less than $0.25 per hour savings in energy cost. For the systems evaluated, a VFD would not pay for itself over a 15-year life.

For Scenario 2 an end gun was installed at the end of the center pivot pipeline. Adding the end gun improved the economics somewhat because the end gun does not operate for the full rotation of the center pivot. Most designs have the end gun turned on for 40 degrees in each corner, which means they would operate for 160 degrees out of a 360-degree revolution or 44% of the time. Use of a VFD could reduce pumping costs by about $0.70 per hour. Still, this scenario was not economical for most center pivot installations.

In Scenario 3, a corner extension was added. When the added pipeline is fully extended into the corner, the flow rate changes substantially. The additional flow rate required by the 350+ foot extension results in increased friction loss in the main portion of the pivot. In most cases the corner extension is totally functional for only about 20 degrees in each corner or 22% of the revolution. The remainder of the circle experiences a gradual change in flow rate as the extension moves into and out of the corner. Thus, the pump impeller selection is based on a flow rate requirement for less than 22% of the system rotation. With the corner extension, use of a VFD conserved about $1.60 per hour of operation.

For Scenario 4, an end gun was placed on the end of the corner extension. In this scenario the end gun functions only about 9 degrees out of each corner. The size of the end gun determines how much energy could be conserved if the pump impeller speed is adjusted based on the need of the center pivot. For Scenario 4 the energy cost savings when using a VFD averaged about $3.00 per hour.

Overall, our results indicate that an electric motor running at a constant 1770 rpm will use excess energy for much of the center pivot revolution. VFD operation includes the installation of a pressure sensor somewhere on the system. The controller part of the VFD adjusts the motor speed to maintain a set pipeline pressure wherever the sensor is positioned. Some sensors are placed at the pump outlet, but if the irrigated area has a lot of topography, that position is often the worst location for the sensor.

Center pivot manufacturers have developed options to place the pressure sensor somewhere on the center pivot. Part of Brar's thesis research evaluated where the pressure sensor should be located to achieve maximum energy conservation. In about 50% of the field sites studied the best pressure sensor location was near Tower 8. For 20% of the systems the best place was near Tower 7 and for 15%, it was near Tower 6. Results point strongly to evaluating each center pivot installation separately to determine where the sensor should be placed on the center pivot.

Herbicide-Resistant Kochia, Palmer, and Waterhemp in the Panhandle: Distribution and Management

Nevin Lawrence – Weed Management Specialist;
Clint Beiermann – Graduate Research Assistant

Figure 1. Left photo: injury to sugarbeets and palmer amaranth from 12 fl oz stinger and 3 pts betamix applied to palmer amaranth less than 2 inches in height. Right photo: center plot was treated with Eptam plus Sonolan PPI along with no POST, the plot on the left was treated with Raptor plus Basagran alone with no PRE, and the plot on the right was untreated.

In the Panhandle of Nebraska, three weed species have been confirmed resistant to glyphosate (Roundup): kochia, palmer amaranth, and waterhemp. All three species have also been confirmed-resistant to ALS (raptor) and Photosystem II (atrazine) inhibiting herbicides in Western Nebraska, and dicamba-resistant kochia has been confirmed in Southwest Nebraska. Further east, certain populations of these species have also become resistant to growth regulators (2,4-D) and HPPD inhibitors (Callisto, Laudis). The impact of these three weed species to a particular farming operation depends on the crops grown, with good options for control available in wheat and corn, and considerably less options available in sugarbeet or dry bean.

For control of pigweeds (palmer amaranth and waterhemp) in dry bean weed scientists in North Dakota have been recommending using Raptor, Basagran, and Reflex at sub-labaled rates and at split application for control. In sugarbeet, herbicide-resistant pigweeds were easily controlled in Michigan using Betamix at 2 pts per acre. Unfortunately, both programs didn't provide sufficient control. So what works in Western Nebraska for control of herbicide-resistant weeds?

- Preplant Incorporated Herbicides (PPIs) provided the best chance for season long weed control in dry bean.
- PRE programs (Prowl H20 with Outlook or Dual) provided good control in light infestations.
- Reflex is the only effective option for post-crop emergent control in dry bean, but may lead to injury in next year's corn crop.
- Betamix failed to control palmer amaranth at 6 pts per acre in field trials, work is ongoing to determine if pigweed is resistant to Betamix.
- Layby application of (Outlook, Sequence, or Dual) can prevent further emergence of pigweeds in sugarbeet.
- To control palmer amaranth, waterhemp, or kochia in corn glyphosate (RoundUp or Touchdown) can not be applied alone.
- Dicamba (Clarity, DiFlexx) at sufficient rates provides good control of kochia, waterhemp, and palmer amaranth in corn. However, if concerned about dicamba-resistant kochia fluoxypyr (Starane) is the best option.

Due to the relatively late planting date of dry bean, kochia isn't as problematic as in other irrigated crops in the Panhandle. Herbicide-resistant pigweeds however, emerge throughout the year in dry bean and can heavily impact yield and harvest operations. Control of herbicide-resistant waterhemp and palmer amaranth is possible through the use of the right PRE or PPI herbicides. In comparison, herbicide options for kochia, waterhemp, and palmer amaranth are lacking in sugarbeet. The best option for control of herbicide-resistant weeds in sugarbeet is with rotational strategies, relying on multiple years of corn or irrigated wheat prior to the sugarbeet crop to reduce the seed bank of herbicide-resistant weeds. Corn and small grains remain the best crops available for controlling herbicide-resistant weeds as there are better herbicide options, and corn and wheat are better competitors.

Managing Pesticide Applications for Me and the Environment

Greg Kruger – Weed Science and Pesticide Application Technology Specialist

Pesticide applications dominate today's agricultural landscape. These applications are critical for mitigating yield loss and managing a wide variety of pests. In today's environment, it is critical that pesticide applicators focus on both managing the pest as well as mitigating environmental impact to non-target areas or non-target organisms. Balancing the two pieces is difficult and has created a dynamic which is changing the way pesticide labels are written and the way we approach pesticide applications.

In 2017, a significant number of off-target movement cases with pesticide applications were reported. For example, 3.6 million acres of soybeans alone were reported with damage from dicamba. Despite having vague, abstract and inconclusive evidence on why so much off-target movement occurred, the have been many theories postulated in the media and other sources of agricultural information outlets. Having an equal or greater number of off-target cases next year could jeopardize the reregistration of dicamba as well as the registration and reregistration of future pesticides. It is critical that applicators recognize their value (both private and commercial applicators) in the continued availability of crop production products in the agricultural industry.

If we look at where we are at, it is imperative to recognize that the pesticide application process is complicated and it is difficult to point to any one thing as the overwhelming problem. While it is cliché to say "the pesticide label is the law", it is really important to recognize that the pesticide label is not only a recommendation but a document in which the user is legally obligated to follow. In regards to dicamba, it is easy to point out that volatility is a contributing factor of the off-target movement that occurred in 2017, but a closer look into things will clearly show that there are many other things that have also contributed to the problems that we observed.

An in-depth analysis will highlight that pesticides can move away from the intended target area in a myriad of different ways. There are two types of pesticide drift: physical particle drift and vapor drift. Physical particle drift is associated with the movement of spray particles away from the intended application site at or near the time of application prior to the particle depositing in the target area. Vapor drift is when the pesticide turns to a gas and then moves away from the target area after it has deposited in the intended application area. Both forms of drift have the potential to cause injury to susceptible vegetation, wildlife and people. It is the responsibility of the entire crop protection industry to work to manage pesticide drift.

The consequences of pesticide drift can be quite significant. In the last two years, there have been numerous incidences of damage from dicamba, particularly on soybean. In 2017 alone, there was 3.6 million acres of dicamba damage reported by Kevin Bradley on soybean nationally. Vapor drift has been a primary culprit that many have pointed to for the challenges that have occurred.

However, with a closer look at the situation it becomes evident that off-target movement occurred because of a wide range of things including but not limited to tank-contamination, physical particle drift, vapor drift, and temperature inversions.

With the newly registered products, there were extremely specific guidelines for how the products need to be applied according to the label. While the extensive label restrictions appear to be cumbersome to applications, it is critical to follow the restrictive guidelines. The restrictions for the new products, in many cases, directly address the major factors that contribute to tank-contamination, physical particle drift, vapor drift and temperature inversions. These label recommendations for the new dicamba formulations provide good recommendations for applying all pesticides in terms of reducing off-target movement as they address the primary underlying principles for off-target movement.

Most of the guidelines for reducing pesticide drift are targeted toward physical particle drift because it is usually a larger contributor to off-target movement than vapor drift and the applicator has greater ability to reduce physical particle drift than vapor drift. A few examples of this can be seen in the pesticide labels for Engenia, Xtendimax and FeXapan. One of the biggest contributors to physical particle drift is wind speed and direction. The labels of these products address this by having a maximum wind speed of 10 mph in which applications can be made and also have language restricting and/or prohibiting applications when the winds are blowing towards certain sensitive crops or habitats. The labels also specify a maximum boom height of 24” because they know that increasing boom height increases the potential for physical particle drift. The label also address distance to sensitive crops habitats through the use of buffer zones recognizing that having greater buffer distances reduces the potential for the products to end up in those same sensitive areas.

The most extensive area where the new labels focus in terms of physical particle drift reduction is droplet size. It is well known that the larger the droplet the lower the potential for off-target movement so the labels have been constructed to ensure that applicators use nozzles, pressures and tank-solutions that will have a low propensity for physical particle drift. Applicators should adhere strictly to these label restrictions to minimize the drift that could occur from the use of these products.

- Pesticide drift, including that from dicamba over the top of dicamba-tolerant crops is a responsibility of the applicator and all others involved in the crop protection industry. Adhering to basic principles of drift reduction is a good practice not only for dicamba but all pesticides. However, applicators should take caution to make sure that they are balancing management of off-target movement with the performance of the pesticide.

The Rise of Multiple-Resistance in Nebraska's Weeds and Effects of Dicamba Micro-Rates on Sensitive Crops

By Stevan Knezevic

Weed resistance to herbicides is a global problem, which usually results from the repeated use of the herbicides with the same mode of action. Simply said: "weeds just got used to that mode of action and cannot be killed with that mode of action anymore". Similar phenomenon is observed in medicine with disease resistance to antibiotics.

Most importantly, after herbicide-resistance develops in weed population at any farm, it stays there as long as that resistant seed is present in the soil, which could last a long time (many decades). For example, the triazine-resistant weeds from the 1980s and ALS-resistant weeds from 1990s are still present at many farms. They were simply forgotten because glyphosate (Roundup) controlled them. However, with the development of glyphosate-resistant weeds (Roundup losing its efficacy), those triazine resistant weeds are now not possible to control with atrazine based products suggesting that the atrazine resistance lasted in many fields for the last 30 years. The atrazine-resistance gene transfers from generation to generation, thus it is the reason for still having triazine and ALS resistant weeds, despite the fact that they been developed 30 and 20 years ago, respectively.

Continual increase in single weed resistance is of great concern, however, what really worries me is the increase in multiple-resistance (multi-stacks) in our major weed species, especially in waterhemp. For example, there has been confirmed cases of multiple resistance (3-stack) in waterhemp to ALS+triazine+PPO or ALS+triazine+HPPD inhibiting herbicides in several other states. There is also a 4-stack resistance in waterhemp to triazine+ALS+PPO+glyphosate in few states. The most worried is the 5-stack resistance in waterhemp, which was confirmed in Illinois and Missouri to ALS+triazine+PPO+HPPD+2,4-D and glyphosate + PPO + ALS + triazine + 2,4-D.

In Nebraska, there are confirmed waterhemp populations that have a 3-stack resistance (triazine+ALS+ glyphosate, or triazine+HPPD+glyphosate). This provides evidence that waterhemp can develop resistance to any herbicide used extensively for its control. Repeated use of the same mode of action can easily result in the evolution of weed resistance, irrespective of the type of herbicide used.

This is a cause of major concern because when weed species start stacking several types of resistance, the number of viable herbicide options gets greatly reduced. For example, having a 4-or 5-stack resistant waterhemp out of primarily 8 modes of action available, leaves only 3 modes of actions left to combat this weed. Further use of the leftover modes of actions will put further pressure on those herbicides, which will result in additional resistance types, thus greatly reducing options for weed control. Therefore, there is a need to diversify weed control programs, which should be based on a variety of chemical and non-chemical tools, including herbicide programs based on different modes of action. This will require the use of both pre-emergence and post-emergence type herbicides.

General guidelines for resistance management:

Regardless the type of weed resistance, these are guidelines for reducing the chance for weed resistance at any farm:

1. Scout fields prior to the application of any herbicide to determine the weed species.
2. Scout your field after herbicide application to look for weed survivors. It takes 10-15 days for glyphosate to kill a weed. It is important to note that many glyphosate resistant weeds may show initial susceptibility to glyphosate (eg. exhibit the appearance of a "dead weed"). However, the "appeared to be a dead weed" can regrow a week or two later from the top of the plant (meristematic growth) or the side (secondary buds, in the form of branches). A branch will take over as a new stem, producing a new plant with resistant seeds for the future infestations.
3. Rotate herbicides, and avoid using same herbicide mode-of-action in the same field in sequential growing seasons or more than once per year.
4. Limit the number of applications of a glyphosate, or any other single herbicide, in a single growing season.

5. Use mixtures of POST herbicides that each control the weeds in question, but have a different site-of-action. Some of the POST broadleaf herbicides will also provide additional soil residual activity for prolonged weed control. Utilize residual based herbicides when possible.
6. Plant into a weed free field. Use other herbicides alone or with glyphosate as burndown treatments for winter annuals including horseweed either in the fall, or spring before crop planting, as it is easier to control those species while they are small.
7. In glyphosate-resistant crops, use soil applied herbicides followed by a single application of glyphosate. This will provide additional modes-of-action for weed control, thus reducing a chance for weed resistance. Soil applied herbicides would also provide a longer “comfort zone” for weed control early in the season by delaying the critical time for weed removal and reducing the need for multiple glyphosate applications later on in the season.
8. Scout fields after application to detect weed regrowth (glyphosate resistant waterhemp will regrow within 3 weeks), or look for escapes or changes in weed species composition (weed shifts). If a potentially resistant weed has been detected, use alternative control methods to prevent the weed from producing seed.
9. Use alternative weed management practices, such as mechanical cultivation, spot spraying with different herbicides, delayed planting, and weed-free crop seeds.
10. Clean equipment before leaving fields infested with or suspected to have resistant weeds.

A great resource for combating weed resistance is the Guide for Weed, Insect and Disease Management in Nebraska (EC130). Additional information about combating weed resistance can be also obtained from www.takeactiononweeds.com.

Dicamba-resistant soybean, known as Roundup Ready 2 Xtend Soybean, was commercially planted in 2017 growing season and is genetically engineered to resistant dicamba and glyphosate. XtendiMax, Engenia and FeXapan were three dicamba products labeled for application in Roundup Ready 2 Xtend Soybean. They can used from planting (burndown application) up to R1 (beginning of flowering) growth stage. All three products are specifically designed to reduce off target movement; however, they are not 100% drift or volatility resistant due to windy conditions and regular temperature inversions occurring in May, June and July in our state.

Since dicamba is a broadleaf killer, any broadleaf plant can be considered a sensitive species. In fact, all non-dicamba tolerant soybeans (eg. Roundup-Ready, Liberty-Link, Conventional) are very sensitive to off target movement of dicamba. Therefore, it is important to be familiar with dicamba injury symptoms (eg. Photos and several videos will be shown during CPC) and associated yield losses. Based on my preliminary results from 2016, all three types of non-dicamba soybeans, tomato and grapes were very sensitive to ultra-low rates of dicamba. Injuries ranged from 70-100% by the 1/10 (1.6oz/A) and 20-60% by 1/100 (0.16oz/A), as well as 20-50% by 1/500 (0.032oz/A) rates applied at V2 stage of Roundup-Ready soybeans. This study was also repeated in 2017 with six micro-rates of dicamba-based products (Clarity, Xtendimax and Engenia). All non-DT soybeans, grapes and tomato showed equally high level of sensitivity to all three products: Clarity, ExtendiMax and Engenia as evident by visual evaluation of injuries collected at 7, 14- and 21 days after herbicide treatments, which was conducted at: (1) 2nd trifoliate (V2); (2) 7th trifoliate/beginning of flowering (V7/R1); and (3) full flowering (R2) growth stages. In particular, all three products equally affected following soybean growth parameters: plant height, number of branches, days to flowering, number of flowers, days to canopy cover, and days to maturity. Since the crop was not harvested at the time of writing article, we can not discuss the herbicide effects on soybean yields. These results reinforce the need for use of proper herbicide application procedures and sprayer cleaning in order to reduce dicamba’s off-target movement.

The Good, the Bad, and the Ugly when Spraying the New Phenoxy Herbicide Formulations in Xtend and Enlist Soybeans

Robert Klein, Emeritus Extension Professor

The Good is that these new phenoxy herbicide formulations will help control tough broadleaf weeds, including resistant and difficult to control weeds in Xtend and Enlist soybeans.

The Bad is that if not used with a weed management plan, we could quickly lose these new formulations to weed resistance.

The Ugly is that if the labels and stewardship are not adhered to, we could have major losses to crops and other vegetation.

The new phenoxy herbicide formulations, including Enlist Duo™ (Dow), XtendiMax® (Monsanto), Engenia™ (BASF), and FeXapan™ (DuPont), offer growers new management options along with new application requirements. XtendiMax, Engenia and FeXapan are dicamba-based herbicides. XtendiMax and FeXapan are identical and use "VaporGrip®" technology to reduce volatility. Engenia uses a new dicamba salt to reduce volatility.

Enlist Duo herbicide has Colex-D technology and combines a new 2,4-D choline and glyphosate, which provides drift reduction in addition to 96% less volatility than 2,4-D ester, according to Dow. Enlist One, a choline only product, will also be available. *Figure 1* illustrates the formulation impact on droplet size from an AIXR nozzle. Limited amounts of Enlist soybeans are being planted.

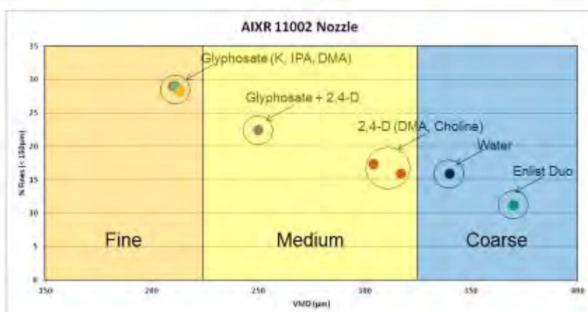


Figure 1. Formulation impact on droplet size from an AIXR nozzle. (Source: Dow)

In the past we have experienced problems when crops resistant to a particular herbicide were commercialized. For example, when Roundup Ready soybean came to the market in 1996, there were a number of problems with spray drift, primarily to corn. Better application practices, including spray nozzle selection, were successful in minimizing the application problems.

Tim Creger, manager of the Nebraska Department of Agriculture Pesticide/Fertilizer Program, note on the first year (2017) of Xtend soybeans follows:

"NDA has received 91 claims of dicamba damage to soybeans, with the last one being received on September 19th. While it is only an estimate, these reports account for approximately 15,000 acres of damaged soybeans, two vineyards (total of 5 acres), and numerous trees (both commercially grown and native). We selected 24 of these reports to conduct active investigations, and were limited to one or two plant samples per complaint for laboratory analysis. To date, all but 5 samples have been reported, with 100% detection of dicamba for samples exhibiting obvious leaf cupping. What is somewhat curious to me is that in those samples collected before July 7th, only dicamba was found, while those collected after July 10th also reported 2,4-D as well as dicamba."

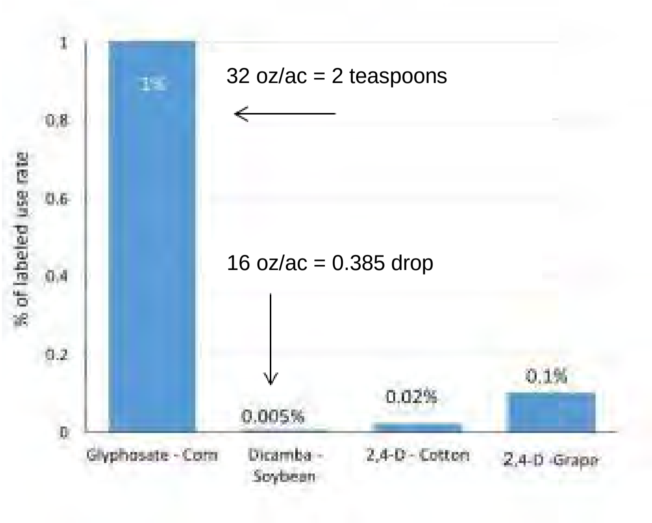
Volatilization of the dicamba products appeared to be the biggest problem in the first year use of these new products. High temperatures during application and the following days after application without doubt contributed to the injury to conventional and non-Xtend soybeans as well as other vegetation.

To alleviate problems when applying new phenoxy herbicide formulations in soybeans as well as to increase herbicide performance, manufacturers have established application requirements. These include:

- Additives – many uncouple the volatility safener in the formulas, resulting in a tank full of much higher volatility dicamba.
- Herbicide rate. It is important to use the labeled application rate to control the weeds and to reduce the chance of selection pressure due to sub-lethal dose. The old saying is “dead weeds don’t produce seeds.” Additionally, the active amount of dicamba varies from product to product so they have a different application rate.
- Spray volume. To reduce spray droplet drift with new phenoxy herbicide formulations, the required nozzles and pressures listed on product labels produce large spray droplets. These large droplets reduce coverage.
- Nozzle types – sizes and pressure. The spray nozzle tip is important because it:
    - Controls the amount applied – GPA
    - Determines the uniformity of application
    - Affects the coverage
    - Affects the spray drift potential
    - Breaks the mix into droplets
    - Forms the spray pattern
    - Propels the droplets in the proper direction
- Spray boom height. Boom height is the second factor in spray droplet drift. When you double the boom height, you increase the amount of spray droplet drift at 90 feet from the sprayer by 350%.
- Weed height. Smaller weeds are easier to control. Crop yields are reduced as the crop competes with weeds for space, nutrients, soil water, and light. Large weeds may also affect coverage.
- Wind speed and temperature inversions. Wind is the number one factor in spray droplet drift. Doubling the wind speed results in seven times more spray droplet drift 90 feet from the sprayer. Check the product label for application requirements relative to wind speed, which is to be taken at boom height both at the start and stop of the application. Consider a smart phone anemometer. Winds of zero to 3 miles per hour may indicate a temperature inversion. In the past, scientists have pegged fog, dew, or frost as signs of a temperature inversion. However, these are characteristic of morning hours, when temperature inversions are usually breaking up for the day. Applicators and growers need to be on alert for clear, windless evenings. When the wind dies down on a clear night, that’s when it’s time to stop spraying. Applications can only be made between sunrise and sunset.
- Volatilization. Temperatures during and following spraying. Spraying dicamba when the temperature is ideal may not stop it from volatilizing two or three days later when the temperature raises.
- Susceptible crops and downwind buffers. The required downwind buffer is listed on the label to help protect sensitive areas. Herbicide applications shouldn’t be made when the wind is blowing toward adjacent susceptible crops or vegetation.
- Ground speed. Most labels for these herbicides contain limits on the maximum ground speed for the sprayer. Boom height controllers usually do not do as good a job at speeds above 14-15 mph as they do at lesser speeds.
- Sprayer cleanout – extremely difficult. It is especially important with these products because even a small amount of residual herbicide can cause serious damage.

Soybeans are highly sensitive to dicamba as shown in *Figure 2*. It only takes 0.385 drop of dicamba per acre (with water there are 456 drops/oz) for significant visual crops response. Studies are being done to determine what levels cause yield losses which are affected by the growth stage in soybeans and the weather.

Again, always check for the latest label information before applying pesticides. These labels help increase pesticide efficacy and spray drift management. The label is also the law.



Source: Not all risk is created equal
Bob Hartzler – July 14, 2017

Figure 2. Lowest observed dose causing significant visual crop response.

Dicamba Off-target Injury Issues in Nebraska Soybean

Amit Jhala, Extension Weed Management Specialist, UNL

Dicamba and glyphosate resistant soybean, also known as Roundup Ready 2 Xtend soybean was available commercially in 2017 growing season. About 500,000 acres were planted with Xtend soybean in Nebraska in 2017 growing season. Three dicamba based herbicides, including XtendiMax, FeXapan, and Engenia are labeled for application in Xtend soybean. They can be applied pre-plant, pre-emergence, or post-emergence until R1 soybean growth stage (beginning of flowering).

In the first week of July 2017, dicamba off-target injury issues started and continued until the end of Aug. Non-Xtend soybean is very sensitive to dicamba. Upward leaf cupping is a typical symptom of dicamba in soybean (Figure 1). Nebraska Extension received 348 dicamba related non Xtend soybean injury complains (Figure 2), primarily in eastern half of the state. Nebraska Department of Agriculture (NDA) is a legal authority to investigate pesticide related injury issues. The NDA received 93 off-target complaints complains in non-Xtend soybean.

Most dicamba injured soybean was able to recover and produce pods and had no impact on yield, except one field that I know of in Nebraska had about 25 bu/acre yield reduction. The grower contacted crop insurance agent, but was able to settle claim because it's a chemical injury. Regardless of impact on yield, off-target movement of any pesticide is a concern.

New Label Requirements for 2018

Considering off-target injury issues in 2017 growing season, United States Environmental Protection Agency (USEPA) has declared new dicamba products (XtendiMax, FeXapan, and Engenia) as a Restricted-Use Pesticide – for use only by Certified Applicators. The new label adds requirements for dicamba spray application training, record keeping, wind speed limitations (3 to 10 miles per hour), application timing restrictions, and more. The 2018 season is the second in the two-year temporary registration granted by the USEPA to Engenia, FeXapan, and XtendiMax. A recent survey of Nebraska soybean growers conducted by UNL weed scientists reported that more Xtend soybean will be planted in 2018 growing season. Therefore, soybean growers in Nebraska are requested to consider dicamba training and follow new label requirements.

Figure 1. Upward cupping of young leaves is a typical symptom of dicamba injury in non-Xtend soybean.

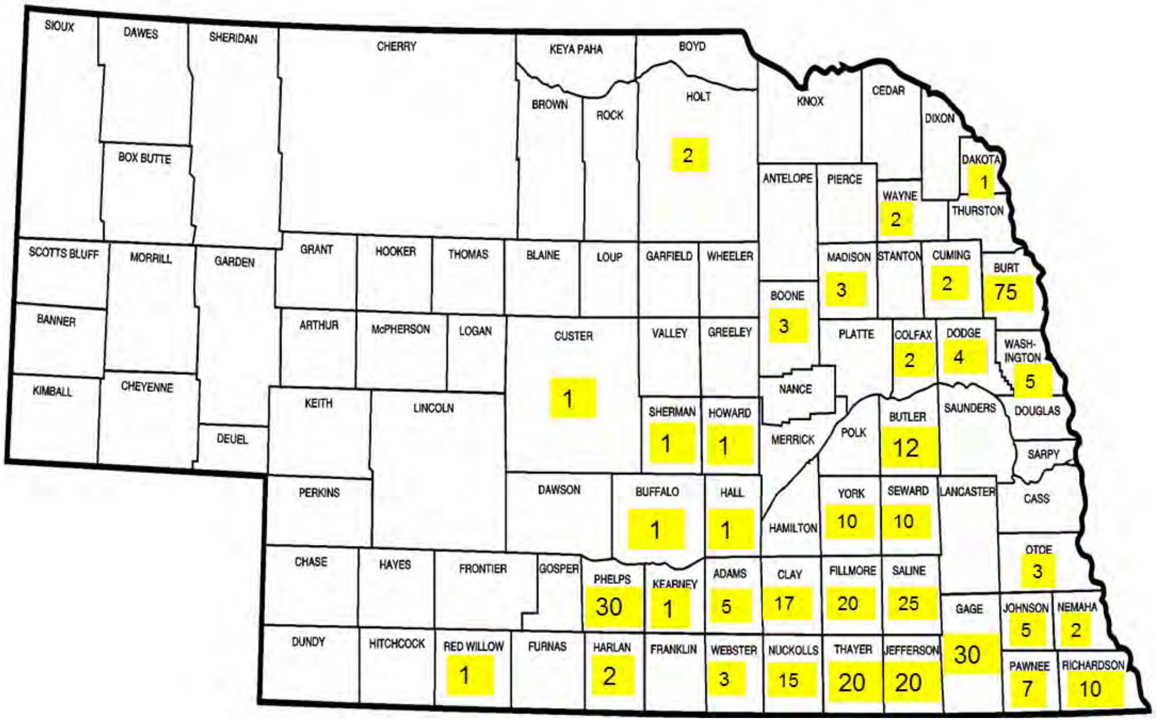


Figure 2. County map of Nebraska with number of dicamba-off target injury complaints received in non-Xtend soybean by Nebraska Extension. A total of 348 complains received that affected about 50,000 non-Xtend soybean acres in 2017 growing season in Nebraska.

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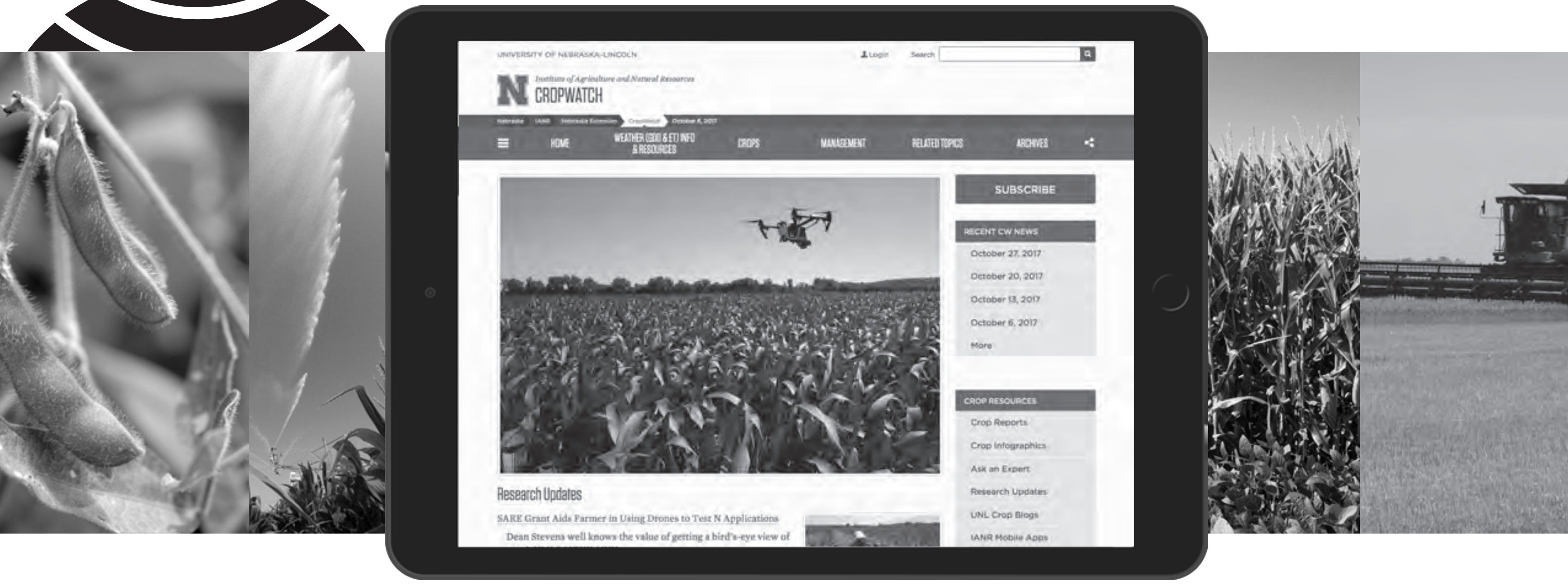

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The 2017 growing season represented the seventh year replicated field research was conducted at the Soybean Management Field Day sites.

Why the need for conducting research at these sites?

Many practical questions regarding soybean production and natural resource sustainability are not answered by current federal and industry funded crop research programs. In addition, the diversity of soybean growing environments in Nebraska, changes in climate, and advancements in production technologies are causing growers to question many long-held assumptions associated with soybean production.

Add to this, today's consumers are asking questions about how and where their food comes from, the increasing world demand for soybeans, and the importance natural resources such as soil and water have on meeting the demand. Subsequently, growers are increasingly challenged to grow soybeans more responsibly.

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Extension is a Division of the Institute of Agriculture and Natural Resources at the University of Nebraska-Lincoln cooperating with the Counties and the United States Department of Agriculture. University of Nebraska-Lincoln Extension educational programs abide with the nondiscrimination policies of the University of Nebraska-Lincoln and the United States Department of Agriculture

Looking for ways to maximize profitability in 2018?

Come hear about research projects conducted in 2017

by farmers across the state in cooperation with Nebraska Extension

Nebraska On-Farm Research Network

2018 Annual Results Update

Feb. 19 | Eastern Nebraska Research and Extension Center, near Mead | 9 a.m.- 4:30 p.m.

Feb. 20 | Lifelong Learning Center, Northeast Community College, Norfolk | 9 a.m.- 4:30 p.m.

Feb. 21 | Hall County Extension Office, College Park Campus, Grand Island | 9 a.m.- 4:30 p.m.

Feb. 27 | Henry J. Stumpf International Wheat Center, Grant | 12 p.m. - 5 p.m. (lunch at noon)

Feb. 28 | Knight Museum & Sandhills Center, Alliance | 9 a.m.- 12 p.m. (lunch follows)

Registration begins at 8:30 a.m. for sessions beginning at 9 a.m.

N EXTENSION

On-Farm Research

Sponsored by: N EXTENSION

In partnership with:

Nebraska CornBoard

NEBRASKA CORN GROWERS ASSOCIATION

NEBRASKA SOYBEAN CHECKOFF

Nebraska Dry Bean Commission

Our Soy Checkoff

Progress Powered by U.S. Farmers

The Nebraska On-Farm Research Network is a statewide on-farm research program addressing critical farmer production, profitability and natural resource questions where growers take an active role in the research. Consider joining us! Learn more...

Visit us on the web: cropwatch.unl.edu/farmresearch.

Follow us on Twitter @OnFarmResearch or Facebook.

There is no cost to attend.

Please pre-register at least 2 days in advance for meal planning purposes.

Contact: onfarm@unl.edu or 402-624-8030.

Certified Crop Advisor Credits are applied for and pending approval .