Proceedings of the
70th Northeast Corn Improvement Conference
(NECIC-29)

February 21-22, 2017
Lord Elgin Hotel
100 Elgin Street, Ottawa, Ontario, Canada

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AGENDA

Tuesday, February 21 (Pearson Room)

07:30-08:30 Registration and Hot Breakfast (included in registration fee)

08:30-09:00 Introductions and Welcome

Lana Reid, *Ottawa Research and Development Centre, Agriculture and Agri-Food Canada*

Dr. Michèle Marcotte, *Director, Research, Development, and Technology, Ottawa Research and Development Centre, Agriculture and Agri-Food Canada*

Session I **Moderator: Peter Thomison, *The Ohio State University***

09:00-09:20 Selection for Corn Inbred Cold Tolerance during Germination and Early Growth.
Malcolm Morrison, Lana Reid, Yvonne Lawley; ORDC-AAFC, University of Manitoba.*

09:20-09:40 Phytoglobin over-expression alleviates drought stress in maize seedlings.
Cassandra Hammond, Mohamed M. Mira, Sylvie Renault, Rob Hill, Claudio Stasolla; University of Manitoba.*

09:40-10:00 Manipulation of Phytoglobin Expression Enhances Flooding Tolerance.
Mohamed M. Mira, Sylvie Renault, Mohamed S. Youssef, Robert D. Hill, Claudio Stasolla; University of Manitoba.*

10:00-10:30 Refreshment Break

10:30-10:50 A New Approach to Corn Silage Forage Quality Evaluation Utilizing the Cornell CNCPS Model.
Joe Lawrence, Thomas Overton, Allison Lawton; Cornell University PRO-DAIRY.*

10:50-11:10 Survey of Corn Silage Hybrid Evaluation Programs at US Universities.
Greg Roth; Penn State.

11:10-11:30 Sugar corn, a New Bioeconomy Feedstock. *Robert Nicol*, T. Hinbest, D. Hooker, D. Young, T. Thiruvengadathan, R. Gomez-Flores, M. Morrison, A. Margaritis, L. Reid, B. Gilroyed; University of Guelph, University of Western Ontario, ORDC-AAFC.*

11:30-12:00 BioEthanol and BioButanol Production from Sugarcorn Extract. *Reyna Gomez-Flores, T.N. Thiruvengadathan, R. Nicol, B. Gilroyed, Argyrios Margaritis*; University of Western Ontario, University of Guelph.*

12:00-13:00 Lunch (included in registration fee)

Session II Moderator: Greg Roth, *Penn State.*

13:00-13:20 Influence of Preceding Crop on Corn Yield, Phosphorus Uptake, and Association with Arbuscular Mycorrhizal Fungi in Manitoba.
Yvonne Lawley, Navneet Brar, Mario Tenuta; University of Manitoba.*

13:20-13:40 Estimating Nitrogen Recommendations for Rainfed Corn Under Variable Climate in the Mixedwood Plains Ecozone of Eastern Canada. *Elizabeth Pattey*, Morteza Mesbah, Guillaume Jégo, Anne Didier, Fasheng Zhang, Nicolas Tremblay, Xiaoyuan Geng; ORDC-AAFC.*

13:40-14:00 Advancing Nitrogen Management for First- and Second-Year Corn Following Alfalfa.
Jeffrey A. Coulter; University of Minnesota.

14:00-14:20 Re-evaluating Narrow Row Hybrid Production in the Eastern US Corn Belt. *Alex Lindsey*, Peter Thomison, Allen Geyer, Kirk Reese; The Ohio State University.*

14:20-14:40 Validation and Application of a Non-destructive Method for Measuring Maize Kernel Moisture. *Lawley, Y. E., Reid, L. M., Nasir Javed*, Brar, N. K.; University of Manitoba and ORDC-AAFC.*

14:40-15:10 Refreshment Break

15:10-15:30 Early Season Defoliation Effects on Tassel Development in Corn.
Peter R. Thomison, Alexander J. Lindsey, Allen B. Geyer, Emerson D. Nafziger, Jeffrey A. Coulter, Mark E. Zarnstorff; The Ohio State University.*

15:30-15:50 Predict Silking Date and Ear Moisture with Corn Heat Units and Other Climatic Factors. *Xiaoyang Zhu* and Lana M. Reid; ORDC- AAFC.*

15:50-16:10 Assessing Thermal Indices for Modeling Grain Corn Phenological Development on the Prairies. *Justice Zhanda*, Paul R. Bullock, Francis Zvomuya, Yvonne Lawley, Lana Reid, Don Flaten; University of Manitoba and ORDC-AAFC.*

16:10-16:30 Quantifying Climate Risk for Grain Corn Production on the Prairies.
Paul Bullock and Justice Zhanda; University of Manitoba.*

16:30-17:00 Discussion on CHU's led by *Paul Bullock.*

Adjourn for the evening- please take all personal belongings with you.

Wednesday, February 22 (Pearson Room)

07:30-08:30 Hot Breakfast (included in registration fee)

Session III Moderator: Bao-Luo Ma, ORDC-AAFC

08:30-08:50 Searching for Candidate Genes Contributing to *Fusarium graminearum* Resistance in a Recombinant Inbred Population.
Aida Z. Kebede, Linda J. Harris, Anne Johnston, Danielle Schneiderman, Whynn Bosnich, Tsegaye Woldemariam, Lana M. Reid; ORDC-AAFC.*

08:50-09:10 Re-emergence and Establishment of the Goss's Bacterial Wilt of Corn in Canada: Pathogen Characterization and Detection. *James T. Tambong*, A. Sidibé, L. Parent, R. Xu, F. Daayf, M.W. Harding, L. M. Reid, R.J. Howard, H. Derksen and A. Tenuta; AAFC-ORDC, University of Manitoba, Alberta Agriculture and Forestry, MAFRD, OMAFRA.*

09:10-09:30 Suppression of Phytoglobin Increases Tolerance of Corn Plants to Goss's wilt.
Veronica Owusu, Mohamed M. Mira, Lorne Adam, Atta Soliman, Fouad Daayf, Robert Hill, Claudio Stasolla; University of Manitoba.*

09:30-09:50 Seed Treatment with Nano-silver Suppressed Goss's Wilt in Corn Seedlings.
Isaac O. Daniel, A. Soliman, L.R. Adam, F. Daayf; University of Manitoba.*

09:50-10:10 Refreshment Break

10:10-10:30 Investigating Defense Genes in Susceptible and Tolerant Inbred lines of Corn (*Zea mays* L.) during Infection by *Clavibacter michiganensis* subsp *nebraskensis*, the causal agent of Goss's Wilt. *AlexanderShumilak*, Atta Soliman, Lorne R. Adam, James T. Tambong, Lana M. Reid, Fouad Daayf; University of Manitoba, ORDC-AAFC.*

10:30-10:50 Proteomic Analysis of Corn Infected with *Clavibacter michiganensis* subsp *nebraskensis*, the Causal Agent of Goss's wilt.
Atta Soliman, Christof Rampitsch, Fouad Daayf; University of Manitoba.*

10:50-11:10 Geographical Distribution of Physiological Races of *Exserohilum turcicum*, the Causal Agent of Northern Corn Leaf Blight in Ontario, Canada.
Krishan Jindal, Albert Tenuta, Tsegaye Woldemariam, Xiaoyang Zhu, D.C. Hooker, L.M. Reid; ORDC-AAFC and OMAFRA.*

11:10-11:30 Molecular Variation of the Northern Corn Leaf Blight Pathogen (*Exserohilum turcicum*) Population in Ontario (Preliminary). *Parivash Shoukouhi, Krishan Jindal, Lana Reid, Tsegaye Woldermariam, Tharcisse Barasubiye, Kasia Dadej, Albert Tenuta, Miao Liu*; ORDC-AAFC and OMAFRA.*

11:30 Close of Sessions

11:30- 12:00 NEC-29 Business meeting

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Selection for Corn Inbred Cold Tolerance during Germination and Early Growth

Malcolm Morrison[*1], Lana Reid[1], Yvonne Lawley[2]*
[1]Ottawa Research and Development Centre, Agriculture and Agri-Food, Ottawa ON K1A 0C6 Canada, [2]Department of Plant Science, University of Manitoba

Over 300 corn inbred lines from the Ottawa RDC improvement program were screened for their capacity to germinate at 9.5 ^{o}C in petri dishes. These lines were also grown in hydroponics in a growth cabinet set at a diurnally fluctuating temperature of 7 to 13 ^{o}C. Fifteen inbred lines were identified from the original lines by these tests and hybrids were made from them at a winter nursery. The constructed hybrids, inbred lines and check hybrids were grown in the field in 2015. Early cold tolerant growth was not a factor in 2015 because of two weeks of warm temperature received shortly after planting. The top 15 yielding hybrids plus checks were grown in 2016 in Ottawa and in Carman Manitoba. Two hybrid combinations yielded as well or better than the mean of six commercial cultivars at both locations. Emergence and early growth was not correlated with yield but days to tassel (Ottawa and Carman) and days to silk (Carman) were. Inbred lines CO338 and CM145 were associated with high yielding hybrids at both locations.

Phytoglobin over-expression alleviates drought stress in maize seedlings

Cassandra Hammond, Rob Hill, Sylvie Renault, Mohamed Mira, Belay Ayele, Claudio Stasolla*
University of Manitoba, Winnipeg, Canada

The effect of water stress generated by applications of 25% w/v polyethylene glycol (PEG) was evaluated in 3-leaf stage (V2) maize (Zea mays L.) seedlings over-expressing or down-regulating the Zea maize phytoglobin 1.1 (ZmPgb1.1) gene. Over-expression of ZmPgb1.1 increased tolerance to drought and resulted in profound changes in the accumulation of ethylene and reactive oxygen species (ROS). Time course analysis of the lines over 0, 4, 8, and 16h showed an increased expression of genes participating in ethylene synthesis and response, as well as ROS production, in the line suppressing ZmPgb1.1. Relative to the wild type (WT) line, reduced expression of the same genes occurred in the ZmPgb1.1 over-expressor. The observed effects were regulated by nitric oxide (NO). While pre-incubation with the NO donor sodium nitroprusside (SNP) induced the transcription of ethylene and ROS generating genes in the WT and ZmPgb1.1 over-expressing line, application of the NO scavenger cPTIO had opposite effects in the WT and ZmPgb1.1 down-regulating line. These results are consistent with the role of Pgbs as NO scavengers. Pharmacological treatments altering ethylene levels and ethylene measurements further showed that this hormone is integrated in the Pbg regulation of drought tolerance. A model is proposed in which suppression of NO by Pgbs reduces ethylene and ROS accumulation, thereby alleviating drought stress.

Manipulation of phytoglobin expression enhances flooding tolerance

Mohamed M. Mira, Sylvie Renault, Mohamed S. Youssef, Robert D. Hill, Claudio Stasolla*
University of Manitoba, Winnipeg, Canada

Hypoxic root growth in maize is influenced by expression of phytoglobins (*ZmPgbs)*. Relative to WT, suppression of *ZmPgb1.1* or *ZmPgb1.2* inhibits growth of roots exposed to 4% oxygen causing structural abnormalities in the root apical meristems. These effects were accompanied by increasing levels of reactive oxygen species (ROS), possibly through the transcriptional induction of four *Respiratory Burst Oxidase Homologs* (*RBOHs*). TUNEL-positive nuclei in meristematic cells indicated the involvement of programmed cell death (PCD) in the process. These cells also accumulated nitric oxide (NO) and stained heavily for ethylene biosynthetic transcripts and 1-aminocyclopropane-1-carboxylic acid (ACC). A sharp increase in the expression level of several ACC synthase (*ZmACS2*, *6*, and *7*), ACC oxidase (*ACO15*, *20*, *31*, and *35*), and ethylene responsive (*ZmERF2* and *ZmEBF1*) genes was observed in hypoxic *ZmPgb*-suppressing roots, that overproduced ethylene. Inhibiting ROS synthesis with diphenyleneiodonium (DPI) or ethylene perception with 1-methylcyclopropene (1-MCP) suppressed PCD, increased the transcription of *BAX inhibitor-1* (*BI-1*), an effective attenuator of the death programs in eukaryotes, and restored root growth. Hypoxic roots over-expressing *ZmPgbs* had the lowest level of ethylene and showed a reduction in ROS staining and TUNEL-positive nuclei in the meristematic cells. These roots retained functional meristems and exhibited the highest growth performance when subjected to hypoxic conditions. Collectively these results suggest a novel function of Pgbs in protecting root apical meristems from hypoxia-induced PCD through mechanisms initiated by NO and mediated by ethylene via ROS

A New Approach to Corn Silage Forage Quality Evaluation Utilizing the Cornell CNCPS Model

Joe Lawrence, Thomas Overton, Allison Lawton*
Cornell University, Department of Animal Science and PRO-DAIRY

Independent Corn Silage Hybrid Testing programs are widely utilized to provide comparisons of hybrid performance. As with any cropping trial there is valuable data to be collected beyond simply measuring yields. In the case of forage crop trials, evaluating the forage quality should carry greater weight than crop yield. While ruminant nutritionists evaluate a number of factors on a forage analysis to determine both the overall quality and specific components of the feed, in crop trials there is always a desire to boil these many factors down to one number that can be utilized to rank hybrids or varieties.

Past examples of these ranking metrics include Relative Feed Value (RFV), Relative Feed Quality (RFQ) and Milk per Ton of Forage as calculated by the MILK2006 (University of Wisconsin). These tools all offered valuable insight into ranking forage performance given the recognized factors of importance at the time of their development.

As advances in ruminant nutrition and forage analysis have continued, there is a need to develop new metrics for ranking forages. The Cornell Net Carbohydrate and Protein System (CNCPS) is a dynamic model used to balance feed rations for cattle. Currently, we estimate that the CNCPS biology (incorporated into several commercial software platforms) is used to feed at least 40% of the cows in the U.S. and is also used in many other parts of the world. With the re-instatement of the New York Corn Silage Hybrid Trials in 2016 the decision was made to utilize the CNCPS model to evaluate the milk producing potential of the hybrids entered into the trials. To accomplish this, a complete ration, typical of what might be fed on a commercial dairy in the Northeastern U.S., was built in CNCPS to predict a milk yield of 100 pounds per day (lbs/day) for a second lactation dairy cow. The ration was built using library feed values for concentrates and average forage analysis data from a commercial laboratory. The next step was to replace the "average" corn silage in the ration with the forage analysis of each hybrid entered into the 2016 New York trials. This provided a predicted milk yield from this same ration as influenced by the differences in the forage analysis of each hybrid. Differences in fiber digestibility, particularly undigested Neutral Detergent Fiber at 240 hours (uNDF240), between hybrids proved to have a major influence on the amount of the total ration that a cow was predicted to consume (dry matter intake). As the amount of uNDF240 decreased, dry matter intake was increased, resulting in an increase in predicted milk yield per day. This approach not only helped highlight differences between hybrids but also presented valuable information on how differences in growing conditions influences fiber digestibility. The utilization of CNCPS offers a method for evaluating corn hybrids that incorporates some of the latest advancements in forage analysis and dairy ration formulation. As with other ranking metrics this method does have some limitations. In practice, a dairy nutritionist would make other adjustments to the diet when a new forage is being utilized in the ration. Whereas past approaches may not fully acknowledge the differences in each hybrid, the uNDF240 adjustment may show a greater difference between hybrids than what will happen in practice.

Logistically this approach requires use of the CNCPS software and the time-consuming task of individual model runs for each hybrid replicate in the trial. Going forward the program aims to build on the opportunities presented by this approach while continuing to evaluate the relationship between model predictions and actual animal performance. Greater adoption would be facilitated by an equation driven approach utilizing the same key factors driving the CNCPS rankings.

Survey of Corn Silage Hybrid Evaluation Programs at US universities

Greg W. Roth
Department of Plant Science, College of Agricultural Sciences, Pennsylvania State University

The objective of this study, conducted during January to May 2016, was to develop some improvements to our corn silage hybrid evaluation program, develop new research opportunities and to develop better coordination between corn hybrid testing programs. I coordinated visits with the University of Wisconsin, University of Vermont, Michigan State University, Virginia Tech, Cornell University and the William H. Miner Institute to the evaluate their testing programs and compare them to ours. Below are some of the observations I collected from this survey at each institution.

University of Wisconsin
This program conducts trials in four maturity zones with two to four locations in each zone and multiple maturity groups in each zone. They report yield, moisture, NDF, Starch and a 48 hour NDFD for each entry and calculate both milk/acre and milk/ton using the Milk 2006 spreadsheet. Analyses are conducted using an in house NIR system housed at the Marshfield research station. Hybrids are sorted by dry matter at each location. Charts are developed that compare milk/acre and milk/ton for each hybrid.

Michigan State University
This program conduct tests over a wide range of geography from Ohio to the Upper Peninsula, across eleven locations and five maturity zones. They report yield, moisture, crude protein, In vitro digestibility (IVD), ADF, NDF, Starch and a 48 hour NDFD for each entry and calculate both milk/acre and milk/ton using the Milk 2006 spreadsheet. Analyses are conducted using an in house NIR system. Hybrids are sorted alphabetically at each location.

Virginia Tech
This program conduct tests at four locations with a 10 day spread in hybrid maturities at each. They report yield, moisture, crude protein, ADF, NDF, Starch and a 48 hour NDFD for each entry and calculate both milk/acre and milk/ton using the Milk 2006 spreadsheet. Analyses are conducted using an in house NIR system housed at the Marshfield research station. Hybrids are sorted by yield at each location.

University of Vermont
This program conduct two tests, one early and one late, at one location with a fairly large spread in hybrid maturities in each. They harvest each test at two different dates to minimize the spread in dry matter at harvest. They report yield, moisture, crude protein, ADF, NDF, Starch and a 30 hour NDFD for each entry and calculate both milk/acre and milk/ton using the Milk 2006 spreadsheet. Analyses are conducted using an in house NIR system. Hybrids are sorted by relative maturity at each location.

Miner Institute

The Miner Institute does not offer routine hybrid testing but is engaged in some hybrid evaluation research and contract testing. In their work they have been evaluating yield, moisture, crude protein, 7 hr starch digestibility, 30 hour NDFD and uNDFD at 240 hours. They have advocated for uNDFD as a better method of describing the fiber digestion and intake potential of forage compared to 30 hour NDFD. They have used the CNCPS and CPM dairy nutrition models to help interpret the silage forage quality data.

Cornell University

At the time of my visit, Cornell had suspended their corn hybrid for silage evaluation program, but has since re-e stablished it in 2016. In the current program, they are evaluating hybrids at two locations with three maturity groups at each. They report yield, moisture, crude protein, lignin, ash, starch, starch digestibility, multiple time points for NDFD and also uNDFD. Analyses are a combination of NIR and wet chemistry conducted with a commercial lab. They are using CNCPS to predict milk yield and dry matter intake. From this they develop charts of milk yield and yield to assess hybrid entries. They sort hybrids by relative maturity.

Penn State

In our program, we conduct approximately 11 trials each year, in four maturity zones. We report yield, moisture, crude protein, NDF, starch, lignin, 24 hour NDFD, uNDF and do a limited amount of evaluations with starch digestibility. Analyses are a combination of NIR and wet chemistry conducted with a commercial lab. Based on input from our advisory group, we are phasing out the use of milk/ton and milk/acre. We sort hybrids by moisture content. We have developed charts for milk per ton and yield and also starch and NDFD in our last report.

Summary

This study revealed that there is a wide range of methods used across the US for hybrid evaluation. There is currently limited use of starch and advanced fiber digestibility measures. There are inconsistent ranking methods as well and different approaches to interpret the data. There is a need for more standardization and a need to develop better tools for interpreting the value of yield and quality. We found that the Cornell program has the most similarities to ours and have begun to collaborate on ways we can begin to standardize some procedures and will be also working with UVM in the future to do this. Eventually we hope we can share our results and rationale to create more standardized approaches to hybrid evaluation in the future.

Sugarcorn, a New Bioeconomy Feedstock

R. Nicol[1], T. Hinbest[1], D. Hooker[1], D. Young[1], T. Thiruvengadathan[2], R. Gomez-Flores[2], M. Morrison[3], A. Margaritis[2], L. Reid[3], B. Gilroyed[1]*

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[2]*Department of Chemical and Biochemical Engineering, Faculty of Engineering, University of Western Ontario, London, Ontario, N6A 5B9, Canada.*

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As demonstrated by the Brazilian ethanol industry, stalk juice from sugarcane is the most efficient biofuel feedstock in the world. Canadian farmers cannot grow sugarcane, but are adept at growing corn. Corn, like sugarcane, is a C4 grass, efficient in utilizing inputs to convert solar energy into sugar which is ultimately stored and then harvested as grain starch. Unlike grain starch, sugarcorn was developed by Agriculture and Agri-Food Canada researchers to produce fermentable sugars in the stalk for temperate and sub-temperate regions of the world where sugarcane cannot be cultivated. Sugarcorn hybrids have been grown at Ridgetown Ontario since 2014. The juice from harvested plants were extracted using a three roller press and this juice, as well as other sugar preparations, have been investigated for production of biofuels and organic acids via fermentation. In terms of ethanol production, this versatile feedstock offers potential advantages over starch including ease of handling via pumping and reduced energy and enzymatic needs during pre-fermentation processes. Although successfully used in other parts of the world, there is currently no industrial use of stalk juice in Canada, and implementation of such an innovative technology requires demonstration of biomass and sugar yields, conversion processes and ultimately the yield and value of product and co-products.

Bioethanol and biobutanol production from sugarcorn juice

*Gomez-Flores, R[1], Thiruvengadathan, T.N.[1], Nicol, R[2], Gilroyed, B[2], and Margaritis, A[1]**
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'Sugarcorn' refers to corn hybrids with high stalk sugars concentration that have been developed by Agriculture and Agri-Food Canada and were tailored to suit Canadian climatic conditions and short growth seasons. Sugarcorn hybrids used in this study were harvested 5-10 days after silking at University of Guelph, Ridgetown campus, Ridgetown, ON. The aim of this study was to investigate the composition of the sugarcorn juice and assess its potential for production of the liquid biofuels bioethanol and biobutanol.

The pH, elemental composition, and concentration of sugars in the juice were determined. The pH of sugarcorn juice ranged between 4.89-5.08 for the samples analyzed. Concentration of carbohydrates in the juice varied from 125 to 180 g/L were the readily fermentable sugars, namely, sucrose, glucose and fructose accounted for about 80%.

Bioethanol fermentation was carried out using *Saccharomyces cerevisiae*, grown in sugarcorn juice medium supplemented with yeast extract achieving 45.62 g/L ethanol in 72 hours of fermentation. Biobutanol was produced using *Clostridium beijerinckii*, a solventogenic bacteria, cultivated anaerobically in diluted sugarcorn juice-P2 medium. A butanol concentration of 8.3 g/L was achieved in 257 h.

Typical features and juice composition of sugarcorn were compared with those of sugarcane, energy cane and sweet sorghum. Finally, a process flow was proposed for production and recovery of bioethanol and biobutanol from sugarcorn feedstock.

Sugarcorn plants can achieve high concentration of stalk sugars in the weeks following silking, thereby saving agricultural resources by aiding an early harvest, without the need to wait for corn maturity. Farmers are familiar with corn cultivation and the associated agricultural machinery, which further enhances its potential as a dedicated Canadian energy crop.

Influence of preceding crop on corn yield, phosphorus uptake, and association with arbuscular mycorrhizal fungi in Manitoba

Yvonne Lawley[1], Navneet Brar[1], Mario Tenuta[2]*
[1]Department of Plant Science, University of Manitoba; [2]Department of Soil Science, University of Manitoba

Recent expansion of corn (*Zea mays*) acreage in Manitoba provides an opportunity to improve crop diversity in existing rotations currently dominated by canola (*Brassica napus*) and wheat (*Triticum aestivum*). Corn grain yield is influenced by crop rotation due to its association with arbuscular mycorrhizal fungi (AMF) for nutrient and water uptake. The abundance of AMF in soil is influenced by the inclusion of crops that host mycorrhize (soybean (*Glycine max*), wheat, corn) or non- mycorrhizal host crops (canola) grown in a rotation. To understand the effects of previous crop on corn grain yield, a two-year crop sequence study was initiated at University of Manitoba Ian N. Morrison Research Farm, near Carman, Manitoba in 2014-15 and 2015-16. Corn, canola, soybean and wheat were grown in sequence year 1 as preceding treatment crops in a randomised complete block design. Corn was grown as a test crop in sequence year 2. Corn plants sampled at the V6 and silking stage were used to measure plant biomass and phosphorus uptake. Corn root samples collected at the same stages were used for assessment of AMF colonization.

Growing conditions for the corn test crop were ideal in 2015 but 2016 had stressful conditions with excessively dry conditions at planting followed by excessively wet conditions that persisted from emergence through to silking. Spring soil P and mineral N concentrations were similar in all the crop sequences before seeding the corn test crop in both 2015 and 2016. Early vegetative growth of the corn test crop was affected by the previous crop. In 2015, V6 corn plants were shorter with lower dry matter yield and P uptake in the canola- corn sequence compared to all other crop sequences. In contrast, corn plants in the soybean-corn sequence were tallest with highest dry matter yield and P uptake at both the V6 stage and silking stage. In 2016 under stressful growing conditions, there were no differences in plant height and early season biomass (P uptake not yet available). Root AMF colonization was lower at the V6 stage for the canola-corn sequence compared to other crop sequences in both 2015 and 2016 but these differences were not present at silking. Despite these early season differences in corn growth and AMF association, there was no significant effect of preceding crop on corn grain yield, moisture, and test weight in both test crop years. The results reported here are from two cycles of the crop sequence experiment and it will be repeated again in 2016-17. Results to date suggest that there is flexibility for optimizing corn in rotation in Manitoba but specific management to optimize early season corn growth should be considered when corn follows canola in rotation.

Estimating Nitrogen recommendations for rainfed corn under variable climate in the Mixedwood Plains ecozone of Eastern Canada

Elizabeth Pattey, Morteza Mesbah, Guillaume Jégo, Anne Didier, Fasheng Zhang, Nicolas Tremblay, Xiaoyuan Geng*
Ottawa Research and Development Centre, Agriculture and Agri-Food, Ottawa ON K1A 0C6 Canada

Managing nitrogen (N) fertilizer applied in agricultural fields is important for increasing corn productivity while limiting the environmental contamination by reactive N. However, the optimum amount of N applied varies significantly depending on soil texture and climatic conditions. A model-based methodology was developed to identify the ecophysiological optimum N rates based on nitrogen use efficiency (NUE) at which the applied N leads to minimum N excess with little loss in yield according to soil texture and climatic conditions. After adapting and verifying the STICS (Simulateur mulTIdisciplinaire pour les Cultures Standard) crop model for eastern Canada corn cultivars, the model was run 14742 times to predict the corn yield responses to N application rates for the proposed methodology. The performance of the methodology was examined via a case study for contrasting soil properties with 48–61 years of daily climate data in five major regions located along an agroclimatic gradient of the Mixedwood Plains ecozone in Canada (42.3^{o}N 83^{o}W–46.8^{o}N 71^{o}W), which includes more than 90% of the total Canadian corn production. Our results indicate that the NUE varied from 0.010 to 0.017 t dry yield kg^{-1} N for different soils and regions. The results also suggest that for an expected dry yield of 8 t ha^{-1} at 0% grain moisture, the recommended N varied from 115 to 199 kg ha^{-1} for cases with low optimum NUE, and varied from 79 to 154 kg ha^{-1} for cases with high optimum NUE. Moreover, our results indicate that soils with lower available water capacity and more clay content tended to require more N fertilization compared to soils with higher available water capacity and more loam content.

Advancing Nitrogen Management for First- and Second-Year Corn Following Alfalfa

Jeffrey A. Coulter – University of Minnesota, St. Paul

Alfalfa (*Medicago sativa* L.) is the third or fourth most dominant crop within states of the Upper Midwest. In this region, corn (*Zea mays* L.) is planted as the first crop following alfalfa on about three-quarters of the hectares and as the second crop following alfalfa on about one-half of the hectares. A key value of alfalfa is the nitrogen (N) contribution that it can provide to at least two years of following crops. The rate and quantity of soil N mineralization following alfalfa is influenced by several factors including soil texture, alfalfa characteristics at termination, agronomic management, and weather conditions. This has contributed to wide variation in N application guidelines for first- and second-year corn following alfalfa among land-grant universities in the Upper Midwest, limited adoption of these guidelines by growers, and frequent cases of excessive N application. To advance N management for first- and second-year corn following alfalfa, a survey of Minnesota growers was conducted, along with on-farm experiments and analysis of datasets from these and previously published experiments from the Upper Midwest. Survey results indicated low adoption of university N rate guidelines for first- and second-year corn, especially when manure was applied. Analysis of field experiments revealed that grain yield of first-year corn is rarely increased with supplemental N except on sandy soils, fine-textured soils when there are prolonged wet early-season conditions, and medium-textured soils when following unusually young alfalfa stands or in some cases when following spring-terminated alfalfa. Grain yield of second-year corn did not respond to supplemental N in one-half of experiments. These findings were used to develop revised guidelines on N management for first- and second-year corn following alfalfa in Minnesota that are more detailed and specific to soil, agronomic management, and crop characteristics. These are expected to reduce the frequency and magnitude of both excess N application and N deficiency in corn, leading to greater adoption by growers. Refinement of these guidelines for enhanced predictability of fields or areas within fields where N application can be eliminated without reducing corn yield will bring additional benefits to farm profitability and water quality.

Re-evaluating narrow row hybrid production in the Eastern U.S. Corn Belt

Alex Lindsey[*1], Peter Thomison[1], Allen Geyer[1], and Kirk Reese[2]*
[1]*Department of Horticulture and Crop Science, The Ohio State University, Columbus, OH.*
[2]*DuPont Pioneer, Lexington, OH*

There has been a resurgence in interest from growers in narrow row (<51 cm) corn (*Zea mays*) hybrid production in recent years in the Eastern U.S. Corn Belt. New hybrids producing greater yield are being grown at higher populations than ever before, and narrow row production may facilitate less within-row competition by distributing the plants more evenly per hectare. Additionally, more even distribution may allow for greater light interception and ultimately grain yield at harvest. Field research trials were initiated in 2016 to address the following research questions: i) do modern hybrids differ in their response to narrow (38-cm) and conventional (76-cm) row spacing?; ii) does narrow row production alter the optimum seeding rate?; and iii) is there a yield advantage for planting hybrids in narrow rows compared to conventional rows?

Two field trials were implemented in 2016 at two locations in Ohio (Western Agricultural Research Station in South Charleston, and the Northwest Agricultural Research Station in Hoytville). The first experiment was evaluating hybrid response (four hybrids ranging in maturity from 105-d to 114-d) to row width (narrow: 38 cm, conventional: 76 cm). The second experiment focused on the interaction of row spacing and seeding rate (ranging from 86,000-111,000 plants/ha). Each experiment was conducted as a split-plot randomized complete block design with row spacing as the whole plot factor, and hybrid or population as the subplot factor. Data collected included normalized difference vegetation index (NDVI), stover yield at harvest, and grain yield at harvest. Data were analyzed using the Mixed procedure in SAS 9.4.

Regardless of hybrid, NDVI values collected above canopy centered between corn rows were greater in 38-cm treatments compared to 76-cm treatments at South Charleston at V7 and Hoytville at V10. Both the 105-d and 114-hybrids exhibited the greatest NDVI values at V7 at South Charleston, and the 114-d hybrid exhibited the greatest NDVI value at Hoytville at V10, but there was no significant interaction between row spacing and hybrid detected indicating similar rates of canopy closure for each hybrid. While grain yield was not impacted by hybrid or row spacing at South Charleston, dry matter yield was greater for the 111-d and 114-d hybrids compared to the 105-d and 106-d hybrids. The 105-d hybrid at Hoytville produced greater grain yield in 76-cm rows compared to 38-cm rows, and the 111-d hybrid producing greater yield in 38-cm rows compared to 76-cm rows. While not significantly different, both the 106-d and 114-d hybrids produced marginally greater yield in 38-cm rows compared to 76-cm rows. No difference in dry matter yield was observed at Hoytville. Regardless of location, the plant population needed to maximize grain yield tended to be greater in 38-cm rows compared to 76-cm rows, but grain yield at the optimum population was similar regardless of row spacing.

Across hybrids or populations, narrow row production resulted in greater grain yield at one of the four research locations and a grain yield reduction at one different location. Dry matter yield means were greater at three of the four locations, but differences between row spacing treatments were not statistically significant. These research trials will be repeated over time to validate the observed results.

Validation and Application of a Nondestructive Method for Measuring Maize Kernel Moisture

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With the expansion of corn (*Zea mays L.*) production in shorter growing season environments, there is an increasing need for a non-destructive method to monitor kernel moisture content in the field to identify genetic traits and agronomic management that result in rapid kernel dry down, early maturity, and lower grain drying costs. Reid et al. (2010. Maydica 55: 163-171) developed a method and calibration curve to use a non-destructive Electrophysics MT808 field meter (Electrophysics, Dutton, Ontario) to measure total ear and kernel moisture content in corn. The purpose of this study was to develop a second calibration data set to validate the meter and calibration curve proposed by Reid et al. (2010) and to evaluate the precision of the meter across the range of moisture contents tested.

A population of corn ears with a range of moisture contents was created for sampling by planting four corn hybrids with a range of Corn Heat Unit requirements at two seeding dates over two years in 2015 and 2016 in an RCBD experiment with three replications. Samples were collected 26, 47 and 61 days after silking in each year by selecting five ears at random from one replication at each sampling date. Samples were brought from the field and processed immediately to measure moisture content using both non-destructive meter and gravimetric methods for the whole ears and ear components. Regression was used to test the relationship between the total ear moisture readings from the meter with gravimetric total ear moisture and kernel moisture contents. An F-test in the Proc Reg procedure of SAS 9.4 (SAS Institute Inc., Cary, NC) was used to test if the slopes of these two models were the same as those published by Reid et al. (2010). The difference between predicted and actual gravimetric total ear and kernel moisture contents was plotted against the gravimetric moisture contents of the ears sampled to evaluate the precision of the model to predict gravimetric moisture content across the range of moisture contents tested.

A new calibration data set was created with gravimetric total ear moisture (TEM) and kernel moisture (KM) contents that ranged from 14.14 to 86.23 percent. Strong relationships between total ear meter readings (TEMR) and gravimetric moisture contents for both total ear (TEM % = 1.17*TEMR) and kernel (KM % = 1.09*TEMR) moisture contents were found with R^2 values of 0.89 and 0.92, respectively. The models had the greatest precision to predict gravimetric moisture between 30 – 55 percent. This supports the earlier findings of Reid et al. (2010) that the meter, MT808 is a good tool for rapid field measurement. In the current study, the best relationship was found between the total ear meter reading and gravimetric kernel moisture. When comparing the slopes of the models from the current study to those published by Reid et al. 2010, slopes for total ear moisture model differed significantly ($P < 0.0001$) but slopes for kernel moisture were not different ($P < 0.1336$). Thus, the results of this study validate the Reid et al. (2010) kernel moisture model but suggest that modifications may be needed for the total ear moisture model.

Early Season Defoliation Effects on Tassel Development in Corn

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Although severe early-season defoliation, such as hail injury, may cause abnormal growth and development of corn tassels, there is limited information in the literature documenting this effect. In a recent multistate study (Illinois, Minnesota, and Ohio) evaluating multiple defoliation events on grain yield, defoliation at V8 resulted in tassel deformation at one of the three sites (Ohio). Deformed tassels had a skeletal appearance and were smaller than tassels of plants that were not defoliated. Spikelets were usually absent from the deformed tassels. To determine if differences in timing and severity of defoliation influenced tassel deformation, tassel appearance at VT/R1 was visually rated and tassel branch number and length measured. One non-defoliated control and 12 defoliation treatments were imposed at three stages of development – V8, V13, and VT/R1. Defoliation treatments consisted of either 100 or 50% leaf removal. Tassel deformity was most pronounced in treatments that included 100% leaf removal treatment at V8 with nearly all plants affected. Tassel length was reduced 36% and branch number per tassel was reduced 7% by 100% leaf removal treatment at V8. The absence of tassel deformation in the Illinois and Minnesota studies, which used hybrids different from that used in Ohio, suggests that certain genetic backgrounds may be more likely to express to tassel deformation in response to early-season defoliation. Further research is needed to identify hybrids and vegetative stages susceptible to tassel deformities following early-season defoliation injury and assess the impact of defoliation induced tassel deformities on corn yields.

Core ideas

1. Severe early-season defoliation, such as hail injury, may cause abnormal growth and development of corn tassels.
2. If defoliation induced tassel deformation occurs within a large field, poor pollen production could greatly reduce yield.
3. Certain genetic backgrounds may be more likely to express tassel deformation in response to early-season defoliation.
4. Further research is needed to identify hybrids and vegetative stages susceptible to tassel deformities following early-season defoliation injury.

Predicting silking date and ear moisture with corn heat units and other climatic factors

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Silking date and ear moisture are two key factors for corn breeding in short season areas, such as Canada. In a specific short season location, the corn growing season depends on the frost date, so the growth period is limited. If silking is late, the number of days for kernel filling will be less, and this will result in lower yields and higher kernel moistures. Therefore, to predict these two factors and to make silking and filling days balanced, it is important to develop hybrids with higher yields and lower moistures. This study is based on our previous data recorded from our silking date and kernel fast drydown studies. R software packages, MASS, nlme , lme4, agricolar, ggplot2, and their related packages are used for regression analysis.

Climatic factors such as daily minimum (Tn) and maximum (Tx) temperatures, daily rainfall, daily bright sunshine hours (Bsh), day length (Dl), and daily total RF1 (Global Solar Radiation, RF1) are used for original data to calculate parameters. Tn and Tx were used to calculate Corn Heat Units (CHU = ∑ [1.8*(Tn-4.4)+3.33*(Tx-10)-0.084*(Tx-10)^2]/2) , Growing Degree Days (GDD = (Tn+Tx)/2-10), and General Thermal Index (GTI =∑ $F_{T,}$ F_T = 0.043177*[(Tx+Tn)/2]^2-0.000894*[(Tx+Tn)/2]^3). The accumulated data are the total of daily data from sow date to observation date (ACHU=∑ CHU, AGDD=∑ GDD, GTI=∑ $F_{T,}$ Arain==∑ rain, ARFA=∑ RF1, ABSH=∑ Bsh) and accumulated Effective sunshine hours (AESH==∑ (Bsh+(Dl-Bsh)/r), where r is the relative photosynthesis ratio based on mean temperature without bright sunshine, in Ottawa, Ontario, Canada, r=6.

Silking days (= silking date – sow date) can be calculated from ACHU, AGDD, GTI, ARF1, ABSH, and AESH divided by their daily means. Among different years, the same genotype has stable AESH, followed by GTI, ACHU, and GDD. AESH*relative photosynthesis rate can be used to calculated silking days when a genotype is introduced to new a location.

Silkdays2 = (AESH*relative photosynthesis rate) at location 1/ (mean(ESH)* relative photosynthesis rate) at location2

When prediction with RF1, ACHU, ARF1, and GTI were better than with AGDD; however; only ACHU and Arain, or ARF1 and Arain together can be used to predict silking days. Leaf number, Plant height, ear-leaf length, ear-leaf width, ear-leaf angle, and total leaf area at silking time were highly related to silking days. These plant traits make genotypic difference and can be considered as genotypic effects.

Ear and kernel moisture were highly related, but kernel moisture is more difficult to predict than ear moisture, because it is affected by husk and cob moisture. Ear moisture can be predicted by ARF1, ACHU, GTI, and AGDD. Considering the tradition of growers to harvest late corn until spring comes, when the winter is cold, RF1 is more important than temperature indexes. Similar, ACHU and Arain, or ARF1 and Arain can be used to predict ear moisture. Only two kernel traits (density (KGHL) and 100-kernel weight) and one plant trait (Ear-leaf mid-point height) were significantly related with ear moisture; however, kernel density and 100-kernel weight were affected by moisture, therefore, they are not independent variance to be used to predict era moisture. Ear-leaf mid-point height was not good enough to be used to predict ear moisture.

The silking days of Hybrids can be predicted by their parents. In Ottawa, our prediction equations are:

Based on ACHU:

Female SilkChu index = 1.5+0.000000098*FsilkCHU^2-0.0005*FsilkCHU

Male SilkCHU index = 1.5+0.000000098*MsilkCHU^2-0.0005*MsilkCHU

Hybrid SilkCHU index = 0.5*(Female SilkCHU index + Male SilkCHU index)

Hybrid SilkCHU = 0.5*(Female silkCHU + Male SilkCHU)*Hybrid SilkCHU index

Example: Female silkCHU=2200, Male silkCHU=1550, then Hybrid silkCHU=1750.

Based on days:

Female Silkdays index = 1.6+0.00008*Fsilkdays^2-0.0154*Fsilkdays

Male Silkdays index = 1.6+0.00008*Msilkdays^2-0.0154*Msilkdays

Hybrid Silkdays index = 0.5*(Female Silkdays index + Male Silkdays index)

Hybrid Silkdays= 0.5*(Female silkdays + Male Silkdays)*Hybrid Silkdays index

Example: Female silkdays=88, Male silking =62, Hybrid silkdays=68

Based on the growth period left for kernel filling, the ear moisture and kernel moisture can be predicted.

Assessing thermal indices for modelling grain corn phenological development on the prairies

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Studies have shown some positive trends in heat unit accumulation in recent decades, increasing the feasibility of grain corn production in cooler regions, such as the Canadian Prairies. Furthermore, producers require a reliable measure for prediction of corn development. A two year field study was initiated in 2015 at six locations in Manitoba and two locations in southern Alberta to quantify heat unit requirements to reach specific developmental stages among five corn hybrids with different maturity ratings. The objective was to identify a thermal index with a consistent accumulation for corn phenological development on the Prairies. The indices assessed included the corn heat unit (CHU), the growing degree day with a base temperature of 10°C (GDD_{10}), the modified growing degree day with a base temperature of 10°C and maximum temperature of 30°C ($mGDD_{10, 30}$), the General Thermal Index (GTI) and days after planting (DAP). The experiment was laid out as a randomized complete block design with site-year as the block, and therefore a random factor, and corn hybrid as a fixed factor. Daily maximum and minimum air temperatures were obtained from onsite automated weather stations to compute the amount of heat required by corn to reach each phenological stage. Corn development from emergence (VE) to silking (R1) was monitored by time lapse cameras set adjacent to each plot and taking pictures at three-hour intervals. Physiological maturity (R6) was defined by the presence of a black/brown layer at the tip of corn kernels. A non-destructive MT808 Electrophysics moisture meter was used to measure weekly kernel moisture content until physiological maturity. The expectation was that the corn hybrids would have significant differences in heat accumulation, especially at physiological maturity. However, there were no significant differences in heat unit accumulation among the five corn hybrids for reaching all phenological stages of development, regardless of the index used in the evaluation. Overall, the five corn hybrids required more CHU than their ratings to reach physiological maturity. The cumulative values for all thermal indices at R6 had a coefficient of variation < 10% but GTI had the lowest (<5%) regardless of the hybrid. The low CV for GTI indicated that the index may be more consistent than other indices in predicting phenological development of corn. Also, the GTI continued to accumulate late in the season, when air temperatures were low, whereas the other indices stopped accumulating. It was clear that the corn also continued to mature under cool temperatures late in the season. The superior performance of the GTI may be related to its more accurate simulation of late season corn development. Additional site-years, especially for early maturing corn hybrids are needed to delineate statistically significant differences in heat unit accumulation by hybrid. Producers are also interested in further evaluation of commercial corn hybrids to assist in selection of appropriate hybrids for their area of production.

Quantifying climate risk for grain corn production on the prairies

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Climate change on the prairies has heightened interest amongst prairie grain producers in growing longer-season and higher heat unit crops, such as grain corn. However, despite the climate changes that have occurred, Western Canada's growing season continues to place severe restrictions on the heat unit requirements for corn hybrids. Outside of the Red River Valley in Manitoba, the frost-free period averages only about 105 to 120 days with mean annual corn heat unit accumulation between 2100 and 2400. In reality, the increase in accumulated CHU has not been evident in all locations and is rather inconsistent spatially across Western Canada. The risk for heat unit accumulation can be determined using long-term historical weather records. This information can illustrate the spatial variation in risk levels for heat accumulation and inform producers about the probability of receiving a specified level of heat unit accumulation for specific locations. Prairie grain producers know that the risk of losing grain corn to a short growing season is high compared to Ontario, Quebec and the USA. They rely on the CHU ratings assigned to corn hybrids as a risk management tool. However, experience has shown that hybrids advertised with low CHU requirements often do not mature as expected. Producers are open to research into new methods that can improve the reliability of corn hybrid heat unit risk assessment and provide them with better information for selecting appropriate hybrids for their farms.

Searching for candidate genes contributing to *Fusarium graminearum* resistance in a recombinant inbred population

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Preventing *Fusarium graminearum* infection (gibberella ear rot, GER) and the associated mycotoxin contamination of grain continues to be a top priority for Canadian corn producers. It has been challenging to identify genes conferring *Fusarium* resistance in cereals because the trait is quite complex and highly influenced by the environment. A recombinant inbred population of 410 lines was constructed from the GER tolerant CO441 inbred developed at AAFC and the GER susceptible reference inbred B73. This population has been phenotyped over several field seasons for GER silk and kernel resistance, smut resistance, kernel drydown rate, and other agronomic traits. Genotyping-By-Sequencing was applied to map ten quantitative trait loci (QTL) each for GERsilk and GERkernel resistance, including four which co-localized in the same chromosomal regions. We surveyed the transcriptomes of the parental lines during early *Fusarium graminearum* infection to characterize their defence response. Gene transcripts responding to fungal infection were captured using RNA-seq profiling of mock and fungal inoculated CO441 and B73 maize ears. More genes were up regulated in the susceptible inbred relative to the resistant inbred, many of which are associated with oxidation-reduction processes potentially causing earlier programmed cell death in the susceptible inbred. Although the hypersensitive response has been effective in controlling biotrophic pathogens, hemibiotroph pathogens such as *F. graminearum* can use it to their advantage to interfere with other forms of host resistance mechanisms. We identified differentially expressed genes located within our QTL regions of GER resistance and have further documented their expression profiles by droplet digital PCR.

Re-emergence and Establishment of Goss's bacterial wilt of corn in Canada: Pathogen characterization and detection

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The re-emergence of the Goss's bacterial wilt and blight of corn (*Zea mays* L.) caused by *Clavibacter michiganensis* subsp. *nebraskensis* (Cmn) has prompted increased research activities to mitigate yield loss. During severe epidemics, losses could be as high as 50% from systemic infections of the xylem. Also, the pathogen is reported to invade seeds leading to potential phytosanitary regulatory challenges for export countries. We report results of a multilocus sequence analysis of 20 ribosomal proteins (rMLSA) and comparative genomics of Cmn strains isolated between 1969 and 2014 to better understand the population structure. In addition, our previously developed TaqMan assay for Cmn detection in pure cultures and infected leaf samples is being optimized for Cmn detection in corn seeds. RMLSA grouped all Cmn strains, irrespective of year of isolation, into two major clusters, suggesting that *rps* genes are suitable for strain differentiation. However, genome and proteome analysis of Cmn strains (DOAB 397 and DOAB 395) isolated in 2014 compared with the type strain, NCPPB 2581 (isolated over 40 years ago) revealed significant differences. The proteomes of strains DOAB 395 and DOAB 397 exhibited a 99.2% homology but had 92.1 and 91.8% homology, respectively, with strain NCPPB 2581. The majority (99.9%) of the protein sequences had a 99.6 to 100% homology between Cmn strains DOAB 395 and DOAB 397, with only four protein sequences (0.1%) exhibiting a similarity <70%. In contrast, 3.0% of the protein sequences of strain DOAB 395 or DOAB 397 showed low homologies (<70%) with the type strain NCPPB 2581. For TaqMan real-time PCR optimization for Cmn detection in corn seeds, preliminary data suggests that different amounts (50, 100, and 200 mg) of the cornmeal did not negatively impact the detection limit. Significant differences, however, were observed between un-autoclaved and autoclaved cornmeals irrespective of the amounts with a very high detection limit (10^6 cfu) for the former. This suggests that unknown and potential biologically active factor(s) in un-autoclaved cornmeal negatively affect the Cmn colonies added or the DNA. Using autoclaved cornmeal, the detection limit was 170 cfu. These results will be discussed during the presentation.

Suppression of phytoglobin (Pgb) increases corn tolerance to Goss's bacterial wilt.

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Goss's wilt, caused by *Clavibacter michiganensis subsp. nebraskensis (Cmn)*, is a recurring disease of corn (*Zea mays*) that is rapidly spreading across the Midwestern USA and Canada. Bacterial diseases are difficult to control because of unavailable resistant hybrids for many crops. The main objective of this study was to evaluate how altered expression of Phytoglobin (Pgb), a hemoglobin-like protein found in plants, influences the behavior of corn plants infected by *Cmn*. Using transgenic corn plants over-expressing or down-regulating a corn plant gene, *ZmPgb1.1*, we showed that suppression of *ZmPgb1.1* is sufficient to reduce lesion size and common symptoms of *Cmn* infection. Preliminary studies also revealed that this increased tolerance to *Cmn* is accompanied by changes in expression pattern of genes participating in jasmonic acid synthesis and signaling, and of genes involved in the production of reactive oxygen species (ROS). Structural analyses indicated that the activation of programmed cell death (PCD) is a response induced by the suppression of *ZmPgb1.1* which might contribute to limiting lesion size in leaves. Collectively, these studies represent a solid framework that can be utilized to further investigate the role played by Pgb during plant-pathogen interaction.

Seed treatment with nano-silver reduces Goss's wilt in corn seedlings

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Clavibacter michiganensis subspecies nebraskanensis (Cmn) is a bacterial pathogen that over-winters in crop stubbles in previously infected fields and causes systemic infection of corn seedlings, resulting into Goss's wilt disease. The disease can cause up to 60% crop loss, and unfortunately fungicide treatment cannot control it since it is a bacterial disease. *In-vitro* trials revealed significant bio-activity of silver nano-particles (AgNPs) against pure cultures of a virulent Cmn isolate (14-5-1). This work was aimed at investigating *in-planta* suppression of Goss's wilt by treating seeds of a susceptible corn hybrid with commercial AgNPs - Econix™, a colloidal suspension product containing 25mg of 5µm AgNPs/ml water. The seeds were primed in serial dilution of Econix™ before potting in soil-less peat in a growth room and after 6 days, the roots of the seedlings were inoculated with the Cmn isolate and a buffer solution control according to protocols in **Dr. Daayf's** lab. Results showed visible improved vigour in seedlings derived from AgNPs-treated seeds in two separate experiments. Goss's wilt disease suppression was close to 50% in seedlings from AgNPs-treated seeds when compared to control at 12 days post-inoculation. Statistical analyses showed that all seedlings from seeds treated with AgNPs had significantly lower estimates of disease severity than control seedlings in both trials. The significant reduction in Goss's wilt severity in AgNPs-treated seeds in both experiments suggests induced resistance (IR). IR investigations by HPLC analysis of secondary metabolites and qRT-PCR analyses of IR genes associated with disease suppression are on-going.

Investigating defense genes in susceptible and tolerant inbred lines of Corn (Zea mays L.) during infection by *Clavibacter michiganensis* subsp *nebraskensis*, the causal agent of Goss's Wilt

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Two corn lines that are susceptible (CO447) and tolerant (CO450) to Goss's wilt, respectively, were inoculated with *Clavibacter michiganensis* subsp *nebraskensis* (CMN) isolates possessing different levels of aggressiveness. The highly aggressive CMN isolate (CMN14-5-1) produced severe symptoms in the susceptible corn line, which started with water soaked areas, and rapidly developed into necrotic lesions. However, the same isolates produced less severe symptoms on the tolerant corn line, which exhibited chlorosis with small necrotic lesions that did not progress beyond the initial 6 days after inoculation (dai) lesion size. Similar results were observed with the less aggressive CMN isolate (DOAB232), though symptoms were less severe overall. The AUDPC of lesion length and disease severity were significantly different between the susceptible and tolerant corn lines inoculated with both CMN isolates. Subsequently, qRT-PCR analysis of 31 genes associated with plant defense was performed on plants challenged with either CMN isolate. Leaf tissue was collected over 4 times points from 0 dai – 6 dai to observe changes in gene expression patterns over time. Three genes, respiratory burst oxidase homolog protein D (*rbohD*), ras-related protein 7 (*Rab7*), and 1-deoxy-D-xylulose-5-phosphate synthase (*DXS*) were upregulated only in the tolerant lines; one gene, jasmonate-zim-domain protein 20 (jaz20), was upregulated only in the susceptible line. Our phenotypic and genotypic data suggests that *rbohD*, *Rab7*, and *DXS* may confer tolerance to CMN in corn.

Proteomic analysis of corn infected with *Clavibacter michiganensis* subsp. *nebraskensis*, the causal agent of Goss's wilt

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Interaction between *Clavibacter michiganensis* subsp. *nebraskensis* and corn was investigated on the proteome level. Two corn lines CO450 and CO447, tolerant and susceptible to Goss's wilt respectively, were infected with two Cmn isolates; DOAB232 and Cmn14-5-1 that possess low and high level of aggressiveness, respectively. Total proteins at 5 DAI were extracted with Acetone-TCA and digested with trypsin. Tryptic peptides were injected into Maldi-TOF MS/MS, and then MS spectra were searched on the Mascot engine against Cmn and *Zea mays* databases. Our results showed that a vast number of proteins belonging to different cellular functional categories were up-regulated in the tolerant corn line CO450 compared to CO447. Proteins involved in ROS production and detoxification were significantly up-regulated in CO450. Also, plant hormones-related genes were up-regulated in CO450 especially, PAL (SA) and LOX (JA). Other categories represented signaling proteins and protein trafficking were expressed differentially in the tested corn lines. Up-regulation of ADP ribosylation factor 2, Glutamine synthetase, and Cysteine protease 2 was seen in the leaf proteome of CO450, while in the root of CO447, Beta-D-glucosidase, Glutamine synthetase, and GF14-6 protein were up-regulated. Protein trafficking also was up-regulated in the leaf of CO450 and in the root of CO447, especially Calmodulin, 14-3-3-like protein and Patellin-3-like protein. Proteins involved in folding and phosphorylation of cellular proteins were up-regulated only in CO450 leaves, except calnexin which up-regulated in the root of CO450 infected with the highly aggressive Cmn isolate. Plant toxins also were identified in both corn lines under infection. Natterin1-like and natterin4 were identified only in leaves, but phytoalexin-related protein was identified in both root and leaves. Energy metabolism-related proteins also were up-regulated in CO450 that represented photosynthesis and cellular respiration proteins. Our results indicate that CO450 possesses effective defense components varied in their cellular functions, which lead to maintenance cellular energy during infection.

Geographical Distribution of Physiological Races of *Exserohilum turcicum*, the causal agent of Northern Corn Leaf Blight in Ontario, Canada

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Northern corn leaf blight (NCLB) caused by *Exserohilum turcicum* (Pass.) Leonard is the most common and economically important fungal leaf disease of the $2.3 Billion Ontario corn crop. Its infection prior to flowering/silking can cause grain yield losses over 50 per cent. Over the past 10 years, NCLB severity and incidence increased many times due to changes in pathogen population (appearance of new races), cultivation practices and climate. To date, 13 races, differentiated on basis of their infection types on four corn inbreds with resistance genes *Ht1*, *Ht2*, *Ht3* and *Htn1*, have been identified in various parts of the world but unfortunately little information is available on the occurrence and distribution of *E. turcicum* races in Ontario/Canada. Therefore the current study was undertaken to determine the spread of NCLB and its pathogen *E. turcicum* races across Ontario, and virulence of identified races against available resistance genes. The disease was found in 83%, 97% and 82% of the fields visited in 2014, 2015 and 2016, respectively. Mean disease severity and incidence in affected crop was higher in southern and western Ontario as compared to eastern Ontario. A total of 675 single conidial isolates of *E. turcicum* were obtained from 687 leaf samples with typical NCLB lesions collected during 2012, 2014, 2015, and 2016 provincial corn disease survey, and from 2013 AAFC central experimental farm plots. Six hundred six of these isolates were evaluated on corn differential lines having *Ht1*, *Ht2*, *Ht3*, *Htm1*, and *Htn1* resistance genes under controlled temperature and light conditions (growth chamber). Sixteen physiological races were identified based on the resistance response (R and S) of the differential corn lines. *Exserohilum turcicum* race 0, 1, 1M, 1N, 1MN and 13MN were most prevalent, comprising 12%, 6%, 12%, 12%, 41%, and 5% of the isolates. Seventy six per cent of the isolates were virulent on more than one *Ht* resistance genes, with 2% of the isolates virulent on all *Ht* resistance genes. Race populations were diverse within regions, counties and years. Virulence to the *Ht1*, *Ht2*, *Ht3*, *Htm1*, and *Htn1* resistance genes was present in 82%, 5%, 10%, 66% and 64% of the isolates, respectively. Most of the virulent isolates produced less number of lesions on *Htm1*, and delayed and smaller small lesions on *Htn1*.Virulence to *Ht* resistance genes was fairly distributed across three years i.e. 2012, 2014 and 2015. Temporal variation was observed among numbers of isolates virulent in all years with less number of isolates virulent on *Ht1*, *Ht3*, Htm1, and Htn1 in 2016 as compared to 2014 and 2015. Number of isolates virulent to *Ht* resistance genes also varied among four regions with less number of isolates virulent on all resistance genes in eastern Ontario as compared to southern and western Ontario. Resistance genes *Ht2* and *Ht3* resisted most of the *E. turcicum* isolates, and lines with *Htm1* produced less number of lesions as compared to other resistance genes. These (*Ht2, Ht3* and *Htm1*) may be incorporated in breeding programs to develop NCLB resistant lines. The information generated in the current study on the distribution of *E. turcicum* races in Ontario corn crop will help growers to select and grow appropriate cultivars with required resistance genes in their area, and seed companies to deploy resistance genes in corn cultivars with specific resistance for a particular region.

Molecular Variation of the Northern Corn Leaf Blight Pathogen (*Exserohilum turcicum*) Population in Ontario (Preliminary)

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In the last 15 years, Northern Corn Leaf Blight has increasingly become problematic in corn production in Ontario. The breakdown of resistant genes indicates likely changes of the genetic structures in the pathogen population. Molecular techniques, i.e. RAPD, AFLP and isozyme, have been used to explore the genetic diversity of *Exserohium turcicum* populations in multiple countries i.e. China, Europe, Israel, Mexico and USA, but not yet in Canada. Haasbroek and colleagues (2014) developed 13 microsatellite markers to characterize *E. turcicum* isolates from South Africa with some success. We evaluated these markers with the 48 fungal isolates collected from Ontario 2014 and 2015 corn crops. Eight markers revealed polymorphisms for the samples tested. The number of alleles and the gene diversity range from 2 – 9, and 0.08 – 0.77 respectively. Although these markers cannot distinguish each individual race, they divided the races into two clusters: cluster 1 included the races that have overcome one to two R genes; cluster 2 two to four R genes, in a neighbor-joining tree. The subdivision was supported by the sub-population (K value) estimation using a model-based Bayesian clustering method (STRUCTURE 2.3.4). Analysis of Molecular Variation (AMOVA) test showed that the differentiation of these two populations is statistically significant, and population 1 has more alleles and higher gene diversity, likely representing more ancestral population, while population 2 is more derived.

Northeast Corn Improvement Conference Business Meeting

February 21, 2017

Lord Elgin Hotel, Ottawa, CN

Present: Xiaoyang Zhu, Peter Thomison, Alex Lindsey, Bao-Lou Ma, Jeff Coulter, Lana Reid, Jim Breining, Jim Valent, Yvonne Lawley, and Keith Payne.

Jim Breining called the meeting to order at 500 pm. Jim asked for approval of the previous minutes from the 2015 meeting and they were unanimously approved.

Jim asked for reports from Industry and University Representatives:

These are summarized below and on the following pages.

Jim Valent, Channel Seeds

Mergers are the big news in the seed industry. Each of the mergers are moving forward. No word yet on what the implications will be. GMO free areas are developing on dairies in the Finger Lakes region. One concern is rootworm control. RR Extend soybeans are a big issue as well. Herbicide resistant weeds are an increasing problem in the region and contamination from the combine is a common cause. Heat and drought stress was an issue throughout the region in corn.

Yvonne Lawley, University of Manitoba

Manitoba has had four years with good fall weather and there is much excitement about corn production there. One of the hurdles is new crop knowledge. Corn is replacing wheat. Soybeans are growing rapidly as well. Some canola acres are being replaced.

Due to time constraints, Lana asked that oral reports be suspended. Everyone agreed and proceeded to discuss options for the next meeting. One suggestion was to return to Cornell for the next meeting but we were unsure if this would be possible. Another suggestion was to return to Baltimore. Greg and Jim agreed to check with Bob Kratochvil at University of Maryland to see what the possibilities might be in finding a good hotel and to see if there might be some interest among faculty and grad students at Maryland or Delaware joining the program. They will report back to the group later this spring.

The meeting was adjourned at 530.

Respectfully submitted,

Greg Roth, Penn State University

Ontario and Quebec production report

Xiaoyang Zhu, Krishan Jindal, and Lana Reid

Weather condition: Favorable spring conditions in most of Ontario and Quebec. In Ottawa, ON, 80-100 CHU more, 80 RF1 more, but 30 mm rainfall less than average year in May; 180 CHU more and 140 RF1 more until August. The frost date was Oct, 11, 2016. Total 260 CHU more, 180 RF1 more, but 100 mm rain less year until frost date in 2016 than average year had. It was a warmer and drier 2016.

Corn production: In Ontario, Grain corn seeded 2.025 million acres in 2016, which was 1.2% less than in 2015 seeded. Grain corn yielded 158 Bu/A in 2016, which was 12 bu/A less (-7.06%) than in 2015 yielded. Total production was 317 million bushes in 2016, decreased 8.7% than 2015's 348 million bushes. Fodder corn seeded 240,000 acres in 2016, decreased 240,000 acres (-4%) from in 2015; yield 20.4 ton/A (-1.9%) in 2016, which was 20.8 ton/A in 2015; total yield 4.8 million tons (-5.9%) in 2016 but 5.1 million ton in 2015.

In Quebec, grain corn acreage increased 4.8%, and yield increased 15.6%, total production increased 21.4% in 2016 than in 2015. Fodder corn Acreage increased 14.5%, yield increase 7.1%, production increased 21.9% in 2016 than in 2015.

Warmer and drier growth season resulted in many corn fields being planted in first quarter of May. The warm and dry weather during the 2016 growing season in conjunction with early planting led to rapid crop development which resulted in a decrease in the incidence and severity of many foliar diseases compared to 2014 and 2015. Northern corn leaf blight (NCLB), common rust and eyespot were the most common leaf diseases found in Ontario corn fields in 2016 but overall the severity and incidence of these diseases was lower compared to earlier years. NCLB and common rust were found in ≥92% of field visited in Southern and Western Ontario with only 16% and 9% of the affected fields having incidence levels of ≥25%, and only three fields of 122 visited having severity of ≥5 (>20% leaf area affected). NCLB incidence was less in fields sampled in Eastern Ontario (4%) compared to Southern (18%) Ontario. Common rust incidence was also more in Southern Ontario (10%) compared to eastern (3%) and Western Ontario (7%). Eyespot was found in 75% of the fields sampled at a mean severity of 2.1 and an incidence of 4.4% of the fields visited. Grey leaf spot (GLS) was localized primarily in Southern Ontario where it was observed in 72% of the fields sampled. Ear and stalk rot diseases were insignificant at the time of survey. Neither Stewart's bacterial wilt nor Goss's bacterial wilt and blight were detected in Ontario in 2016.

2016 Ohio State Report

P.R. Thomison, The Ohio State University

The 2016 Ohio growing season was characterized by cool, wet conditions in April and May followed by warmer and drier than normal conditions from late June to early-mid August, especially in parts of northern and western Ohio. According to the U.S. Drought Monitor during the second week of August, 46 percent of the state was rated as in "moderate drought" with that area covering most of northern Ohio. Another 15 percent of the state was rated in "severe drought" with that area spreading from west central Ohio to northeast Ohio. Hot, dry conditions at pollination and early grain fill resulted in poor kernel set and ear tip fill but timely rains in August and September reduced the impact of the drought on yield. Premature kernel sprouting and moldy grain caused by ear and kernel fungi, including Diplodia, Gibberella, and Trichoderma fungi, were present in localized areas across the state and were often more evident in early planted, earlier maturing hybrids. Foliar diseases and insect pests were not a major factor at most test sites. There were reports of major stalk lodging in localized areas but stalk quality problems were generally not widespread and negligible. Warm, dry conditions in September and October promoted crop maturation and dry down.

In 2016, 212 corn hybrids representing 26 commercial brands were evaluated in the Ohio Corn Performance Test (OCPT). Four tests were established in the Southwestern/West Central/Central (SW/WC/C) region and three tests were established in the Northwestern (NW) and North Central/Northeastern (NC/NE) regions (for a total of ten test sites statewide). Hybrid entries in the regional tests were planted in either an early or a full season maturity trial. These test sites provided a range of growing conditions and production environments.

Yields varied across the state depending on the timing and duration of drought conditions. Averaged across hybrid entries in the early and full season tests, yields were 241 bu/A in the Southwestern/West Central/Central region, 195 bu/A in the Northwestern region, and 197 bu/A in the North Central/Northeastern region. Yields at individual test sites, averaged across hybrid entries in the early and full season tests, ranged from 163 bu/A at Wooster to 256 bu/A at Hebron. The Wooster, Hoytville and Van Wert test sites were especially dry in June and July and averaged lower yields than other test locations. The full season tests averaged consistently higher yields than the early tests. Moldy grain was observed in some hybrids at Hebron and Beloit. Moderate to high levels of gray leaf spot were evident in a few hybrids at Bucyrus and Beloit. Lodging was largely absent across sites except at S. Charleston where some hybrids lodged as a result of heavy rains and strong winds in late August.

Tables 1 and 2 provide an overview of 2016 hybrid performance in the early maturity and full season hybrid trials by region. Averages for grain yield and other measures of agronomic performance are indicated for each region. In addition, the range in regional test site averages is shown in parentheses.

Table 1. A regional overview of the early maturity 2016 Ohio Corn Performance Test.

Region	Entries	Grain Yield (Bu/A)	Moisture (%)	Lodging (%)	Emergence (%)	Final Stand (plants/A)	Test Wt. (lbs/bu)
SW/WC/C	85	235 (196-258)	18.2 (14.9-20.4)	1 (0-17)	94 (86-98)	33200 (29700-36500)	56.1 (52.8-59.1)
NW	85	191 (170-209)	18.2 (15.6-20.6)	1 (0-5)	95 (85-99)	33500 (29400-38700)	57.8 (55.2-61.1)
NE/NC	73	189 (168-212)	19.3 (15.4-22.1)	0 (0-3)	96 (82-99)	33600 (28600-36000)	57.1 (54.0-60.3)

Table 2. A regional overview of the full season 2016 Ohio Corn Performance Test.

Region	Entries	Grain Yield (Bu/A)	Moisture (%)	Lodging (%)	Emergence (%)	Final Stand (plants/A)	Test Wt. (lbs/bu)
SW/WC/C	46	246 (222-264)	20.1 (17.6-22.0)	1 (0-6)	95 (85-98)	33400 (28800-35700)	55.7 (53.3-58.0)
NW	77	198 (179-215)	19.9 (16.7-23.0)	1 (0-23)	96 (91-99)	33700 (29500-38500)	56.7 (53.0-59.5)
NE/NC	48	205 (181-224)	21.5 (18.3-24.8)	1 (0-4)	97 (90-99)	33900 (29400-36400)	55.8 (52.5-58.8)

Source:
Rich Minyo, Allen Geyer, Peter Thomison, and David Lohnes. 2016. 2016 Ohio Corn Performance Test: Regional Overviews. C.O.R.N. Newsletter. OSU Extension. 12-01-2016.

2016 PA State Report

Jim Breining

The growing season, 2016 could best be described as a year of extremes. The winter 2015-2016 was one of the warmest on record. Snow and rainfall through the winter months were below average statewide. March and April saw continued above normal temperatures and near normal rainfall. Field conditions for planting were near optimum the last week of April, and many acres of corn were planted statewide. By May 1st, the central and southern parts of the state were again saturated with rainfall and field conditions were unfit for planting for one to three weeks. The northern tier saw less rainfall and planting began again around May 9. Planting didn't begin again in the southern part of the state until May 16. Most corn acres were planted before June 1. Some of the earliest planted corn saw stand reductions due to continued cold and saturated soils, but overall, stand establishment was good.

The summer months June – August were generally warm and dry. The center region of the state experienced severe drought through much of this time frame and plant height and ear development were severely impacted. Around the perimeter of the state, conditions were somewhat better and corn yields in those areas were average to much above average. The harvest season September –November were generally very good with continued warmer than normal temperatures and timely rainfall. Yield response was greatest on later planted fields, especially in the center region of the state.

Corn disease pressure was very light and didn't contribute any stand or yield reductions.

The year-end NASS report indicated 1,400,000 acres were planted to corn in 2016, an increase of 60,000 acres over 2015. Corn harvested for grain acres were 950,000, an increase of 10,000 acres from 2015. Corn silage acres harvested were 440,000, 50,000 acres more than 2015.

Corn yield for grain was set at 129 bu/acre, a decrease of 18 bu/acre from 2015.

Corn silage yield was estimated at 17.5 ton/acre, a reduction of 2.5 tons/acre from 2015.

The Pennsylvania commercial corn trials reported the follow information:

Corn Silage trials

Trial	Yield
G0/1	19.8 tons/acre
G2	17.4 tons/acre
G2SC	22.7 tons/acre
G3/4	24.5 tons/acre

Number of participating companies – 17
Number of entries – 163 (18 conventional)
Range of plantings – 5/9 - 6/1

Corn Grain trials

Trial	Yield	Range
Z1	175.9	151.5-205.4
Z2	177.3	150.2-216.1
Z3/4	204.9	201.8-210.7

Number of participating companies – 14
Number of entries – 106 (0 conv.)
Range of plantings 4/25 - 5/26

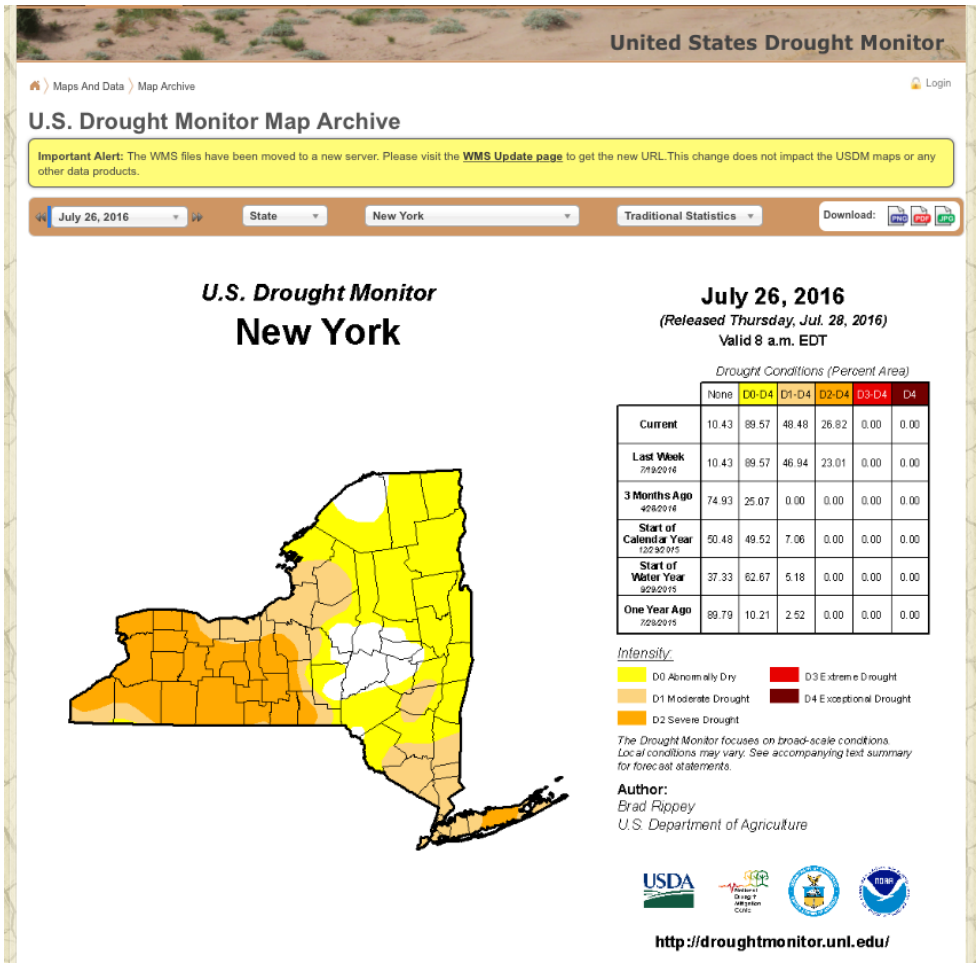
2016 New York State Report

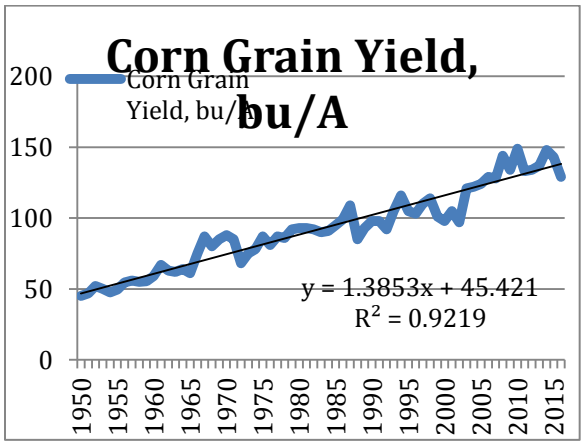
Sherrie Norman, Keith Payne, Daniel Fisher, Margaret Smith

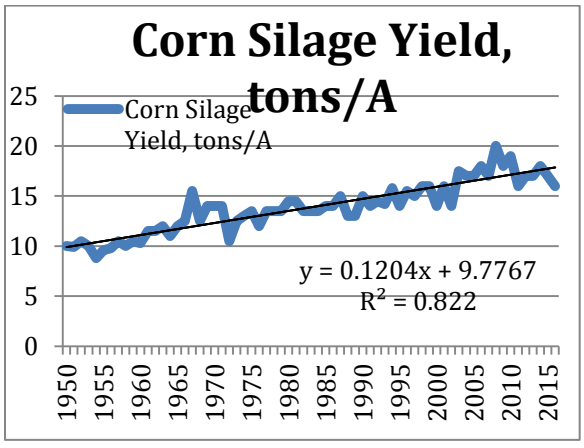
The 2016 season in New York had some precipitation extremes, but in different directions from what we saw in 2015. While 2015 was characterized by unusually high rainfall in early summer, 2016 was generally dry through much of the summer, and some parts of the state experienced significant drought. Typical growing season temperatures and generally dry conditions in May allowed for timely planting and good crop establishment. Beginning in June, however, the state experienced varying levels of drought combined with above average temperatures, resulting in drought-stressed corn in many areas. Those spots that had timely rains survived well, but some areas had significant crop losses. By 26 July 2016, the USDA Drought Monitor web site for New York recorded 27% of the state's area in severe drought conditions (D2), 22% in moderate drought (D1), and 41% abnormally dry (D0). Only 10% of the state's area was assessed as not drought stressed at this time (see figure below). This was the most extreme level of growing-season drought stress in NY that most people could recall. Cornell yield trials in New Hope (eastern Finger Lakes area) and Pittsford (central shore of Lake Ontario, near Rochester) had less than 80% of average growing season rainfall combined with warmer-than-average temperatures, while those in Albion (northwestern NY) and Kingston (southeastern NY – Hudson River Valley area) had less than 67% of average growing season rainfall and high temperatures. Most trial sites other than Kingston had very high rainfall in October (anywhere from 25% above average to more than twice the average monthly total). Our breeding nursery location in Aurora had 8" of rainfall in October alone! Needless to say, this complicated harvesting operations. The 8" of October rainfall at Aurora brought season-long precipitation totals to only 2" below 30-year averages (91%), which belies the fact that May through July totals were 6" (43%) below the long-tem averages.

Generally dry conditions through the summer months resulted in very little leaf disease pressure during 2016. Insect pressure also was minimal.

Given the summer water stress in 2016, yields on New York's 570,000 acres harvested as grain were surprisingly good. State average yield was reported at 129 bu/acre – 20 bu/acre lower than the record 2010 and 2014 yields, but still the 9th highest state corn grain yield reported. This drop-off in 2016 did not change the trend line for New York corn grain yields, which have increased at a rate of 1.4 bu/acre/year for the past 65 years (see graph below). Yields for New York's 510,000 acres harvested as silage averaged 16 tons/acre in 2016, which was at the bottom of the range of silage yields over the past 14 years, but equal to or higher than all state averages prior to 2003. The trend line for silage yield increases has been fairly steady at 0.12 tons/acre/year for the past 65 years (see graph below).


United States Drought Monitor
Maps And Data
Map Archive
Login
U.S. Drought Monitor Map Archive
Important Alert: The WMS files have been moved to a new server. Please visit the WMS Update page to get the new URL.This change does not impact the USDM maps or any other data products.
July 26, 2016
State
New York
Traditional Statistics
Download:
U.S. Drought Monitor
New York
July 26, 2016
(Released Thursday, Jul. 28, 2016)
Valid 8 a.m. EDT
Drought Conditions (Percent Area)
None D0-D4 D1-D4 D2-D4 D3-D4 D4
Current 10.43 89.57 48.48 26.82 0.00 0.00
Last Week 7/19/2016 10.43 89.57 46.94 23.01 0.00 0.00
3 Months Ago 4/26/2016 74.93 25.07 0.00 0.00 0.00 0.00
Start of Calendar Year 12/29/2015 50.48 49.52 7.06 0.00 0.00 0.00
Start of Water Year 9/29/2015 37.33 62.67 5.18 0.00 0.00 0.00
One Year Ago 7/28/2015 89.79 10.21 2.52 0.00 0.00 0.00
Intensity:
D0 Abnormally Dry
D1 Moderate Drought
D2 Severe Drought
D3 Extreme Drought
D4 Exceptional Drought
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.
Author:
Brad Rippey
U.S. Department of Agriculture
http://droughtmonitor.unl.edu/


Corn Grain Yield, bu/A
Corn Grain Yield, bu/A
y = 1.3853x + 45.421
R² = 0.9219
200
150
100
50
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015


Corn Silage Yield, tons/A
Corn Silage Yield, tons/A
y = 0.1204x + 9.7767
R² = 0.822
25
20
15
10
5
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015

Minnesota Report – 2017 Northeastern Corn Improvement Conference

Jeffrey A. Coulter, Ph.D.
Associate Professor and Extension Specialist, Corn-Based Cropping Systems
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Corn was planted on 8.45 million acres in Minnesota in 2016, up from 8.1 to 8.2 million acres during the previous two years. About 95% of Minnesota's corn was harvested for grain in 2016, similar to prior years. The 2016 growing season was generally favorable for corn production. Planting began slightly ahead of normal in mid-April and about 60% of the state's corn was planted by the end of April. A freeze in mid-May impacted many acres of early-planted corn throughout the state. Freeze-damaged corn generally recovered with limited reductions in yield. Warmer-than-normal air temperatures resulted in pollination that was about one week or more ahead of normal and largely during mid-July. Modest heat stress occurred soon after pollination in much of southern Minnesota, but generally was not accompanied by lack of soil moisture. Air temperature and soil moisture during the remainder of the growing season were generally conducive for kernel maintenance and grain fill, although there was considerable variability in conditions across the state. Excessive precipitation occurred in mid-September in many areas of southern and central Minnesota, creating challenges with timely harvest, particularly for corn harvested as silage. Silage yield averaged 21.5 tons per acre across the state, similar to that in 2015 and 19% greater than that in 2014. Record grain yield (statewide average = 193 bushels per acre) occurred in 2016, with greatest yields typically in western Minnesota. In comparison, grain yield averaged 188 and 156 bushels per acre in 2015 and 2014, respectively.

Palmer amaranth, an exceptionally-competitive and aggressive weed of the pigweed family, was detected for the first time in Minnesota in 2016 and is a concern to growers and crop advisors. Continued performance problems of certain Bt corn rootworm traits against corn rootworm persist. A major emphasis in Minnesota is improving water quality, largely through enhanced nitrogen management and new legislation mandating permanent vegetative buffers along waterways.

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