Final Report
Developing the Next Generation of Faster Drier Corn Products for Northern MN
Project 4103-13SP

Project Title
Developing the Next Generation of Faster Drier Corn Products for Northern MN

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Abstract
Annually, the upper Midwest consumes more than $1.4 billion of fossil fuels to dry $19.7 billion of corn grain. Still, few industry inbred lines and hybrids are fast driers and, therefore, viable for central and northern Minnesota (MN) corn production. The objective of this research was to identify, scientifically, corn lines and hybrids with fast rate of dry down for the U.S. northern market through a revolutionary method developed at NDSU. Breeding efforts for fast dry down in a short-season corn sample representing the NDSU EarlyGEM adaptation program, NDSU elite x elite crosses, NDSU x ex-PVP, and NDSU recurrent selection programs for germplasm improvement were conducted. Most advanced faster drier lines were screened and crossed in hybrid combinations with industry and NDSU testers. Hybrid seed was produced and utilized for conducting 2013 and 2014 hybrid experiments across northern U.S. locations. The AUDDC method invented by our project has demonstrated to be accurate and reliable and was used, particularly in this project, in order to develop faster drier hybrids targeted at MN challenging short-season growing conditions. This project has generated not only new cultivars but also validated a new breeding methodology which was adopted by industry breeding programs during the time of this project. As a consequence, 12 new fast drying cultivars were developed during the 2013-2014 seasons. Therefore, in addition to validating a new and unique breeding methodology, the NDSU corn breeding program release and distributed new products with dry down rate advantages, when compared to industry checks, to industry. Identifying faster drying corn lines and hybrids has been a very difficult task over time. Rate of dry down can only be identified for screening between physiological maturity and grain moisture at harvest. It is genetically a very complex trait since many genes are involved and it has been very difficult to measure for breeding purposes over decades. Even though this is a trait that would be an ideal one to be targeted with genomic technology it has demonstrated to be even more difficult to address with modern technology as well. Therefore, no method has been developed either in the public or private sectors in order to develop faster drying hybrids over time. NDSU and its invention has demonstrated it is possible with a reliable method which will continue to aid the increased of corn production and profitability of northern U.S. farmers by reducing their cost.
Introduction

Northern MN corn often needs to be harvested at moisture levels too high for safe storage and must be artificially dried for storage and transport. MN corn farmers still continue to spend millions of dollars in corn grain drying due to the lack of short-season faster drying corn hybrid.

Field dry down in corn refers to moisture reduction after physiological maturity. Fast field dry down after physiological maturity is one of the most important features for the stability of short-season corn hybrids especially in the northern USA (Hallauer et al., 2010).

The NDSU corn breeding program has been recognized for the first invention in efficiently measuring rate of dry down in corn. NDSU developed AUDDC-area under the dry down curve (Yang et al., 2010), a scientific and practical method toward helping save billions of dollars to drying corn through the development of short-season faster drier corn lines and hybrids. NDSU validated its discovery on screening corn inbred lines and hybrids for fast dry down. This could reduce grower’s production cost related to artificial grain drying. Public and private institutions can take advantage of this method developed at NDSU. This method, through our preliminary data, has demonstrated to be accurate and reliable and could be used by our major industry partners in order to offer faster drier hybrids in northern MN. Moreover, this method can be extended to all areas of corn production (e.g., both northern and southern MN) in order to reduce the impact of climate changes on corn production as well (Carena et al., 2009b; Carena, 2011).

Objectives

The objective of this research was to identify, scientifically, corn lines and hybrids with fast rate of dry down for the U.S. northern market through a revolutionary method developed at NDSU. This project targeted the generation of not only new cultivars but also the validation of a new breeding methodology representing breeding programs that develop not only cultivars but also new methods.

Materials and Methods

Thousands of inbred lines were screened for fast dry down in winter and summer nurseries. Hybrids including selected lines for fast dry down (Eno and Carena, 2008; Carena et al., 2010) were evaluated in extensive experiments arranged in partially balanced lattice designs across northern U.S. environments. Ear moisture data of thousands of genotypes were collected at four 7-day intervals with an electronic moisture meter BLD5604 starting 45 days after pollination. The area under the dry down curve (AUDDC) was the proposed method utilized to evaluate dry down and it was calculated based on four rating dates to represent dry down rate. We proposed AUDDC as an index for fast dry down selection using BLD5604, which can reliably phenotype this trait unlike methods proposed in the past. Based on combining ability analyses and heritability index selection, inbred lines with potential for hybrid development were identified. Hybrids were tested against top industry checks.
An index—Area Under the Dry Down Curve (AUDDC)—was proposed as the selection criterion for field dry down. AUDDC was tested to provide maximum information about a dynamic progress based on repeated measurements. AUDDC was created and calculated based on converted meter reading on all measure dates. Lower AUDDC values represent faster field dry down rate, and higher AUDDC values represent slower dry down rate (Fig 1). The formula used to calculate AUDDC follows:

\[
AUDDC = \sum_{i=1}^{n-1} \frac{(y_i + y_{i+1})(t_{i+1} - t_i)}{2}
\]

where \( n \) is number of assessment times, \( y \) is converted meter reading, \( i \) is the \( i^{th} \) rating date and \( t \) is time (in days).

![Figure 1. Area under the dry down curve (AUDDC) representing faster and slower dry down progress in corn hybrids.](image)

**Results and Discussion**

Thousands of lines, hybrids, and populations were evaluated with top industry checks. New 12 fast drying cultivars were developed during 2013-2014 seasons. These were released and distributed to industry exclusively and non-exclusively. Corn royalties and fees were received. PVP disclosure forms on the new cultivars were signed by NDSU technical and administrative offices. New knowledge was validated through AUDDC data and the next generation of fast drier products was initiated. Rate of dry down was confirmed to be controlled genetically and the new method was able to successfully discriminate the strengths and weaknesses of lines and hybrids for this economically important trait. Major industry partners are already utilizing this NDSU corn breeding methodology.
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Conclusion

This project was of particular benefit to MN corn farmers and industry since it addressed the need of fast dry down lines and hybrids for central and northern MN. The NDSU corn breeding program is the first breeding program to address dry down challenges for this area through the invention of the AUDDC new breeding methodology and the development of unique products. Next research steps are to continue breeding for faster drier short-season corn products targeted at reducing the significant cost corn farmers face annually in central and northern MN.

The AUDDC method will simplify the phenotyping of dry down in both the public and private sector, will increase the capacity and speed of identifying faster drier hybrids, and will complement basic molecular studies with classical quantitative genetics and breeding.

Education, Outreach, and Publications

Keynote Lectures and Invitations with exposure to this project:

- January: Minnesota Corn Research and Promotion Council, US
- February: North Dakota Corn Utilization Council, US
- March – April: Several private and public national and international institutions from South America and Asia.
- August – September 2013: Private and public institutions from Puerto Rico, China, and Germany.

Fargo, ND North Dakota State University Field Days:

- Over 100 people touring winter nurseries for seed production and screening for cold and drought tolerance with thousands of new genetic materials.
- 4 Ph.D. students as major advisor, 17 students as instructor in Quantitative Genetics, 16 students as instructor in Crop Breeding Techniques, where products and procedures were directly exposed.
- >500 national/international nursery visitors, and main consultant to several institutions, toured summer breeding nursery with new line and population releases.

2013-2014 Manuscripts


References


