Corn Marketing Program Report 2016

Title: Attaining the 300 bushel yield goal on high productive soils through climate tolerant hybrids, increased population densities and nitrogen management

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Collaborators: MSU Faculty, MSUE Field Crops Team, Capital Area Innovative Farmers

Introduction

Reaching the elusive 300 bu/A corn yield goal under dryland conditions in Michigan will be a significant milestone for corn producers in terms of profitability. Most recent corn yield contest winners in this area have consistently achieved 300 bu/A on irrigated highly productive land. We believe that yield goals of above 250 bu/A are currently attainable under dryland conditions by a combination of new genetics and smart agriculture practices. Obviously, the biggest unknown is how the current season weather will influence the critical growth stages of corn.

Both field research and computer models have shown that the most practical short-term approach towards reaching the 300 bu/A yield goal with modern hybrids is to plant the right population and properly manage nitrogen (N) throughout the season.

Technically, higher populations makes it possible to harvest more ears and kernels per acre. At high densities, corn will quickly establish a full canopy and intercept more sunlight for photosynthesis. Some of the newly released hybrids have strong stalks, robust root systems and erect stature, enabling them to adapt well to high populations.

Another factor in play is the hybrid ear type, 'flexed' versus 'fixed'. Flexed ear types are more 'opportunistic', they are able adjust their late season yield components such as kernels per row and kernel weight, depending on how favorable the growing conditions. Fixed ear hybrids have a determinate ear type that limits it capacity to change during the season. Therefore planting the 'right' population is more critical to fixed ear types compared to flexed ear types.

Other key requirements to reach the 300 bu/A yield goal are adequate nitrogen (N) and soil moisture. Nitrogen rate, timing, source and placement have critical roles so that N is available when needed and not lost to leaching and denitrification. In 2014 and 2015, we tested two static N treatments of 120 and 240 pounds N per acre, where 40 pounds N was applied at planting and the balance sidedressed at V5-V6. In both years, we encountered heavy rainfall in June and July coinciding with the traditional sidedress N application. This resulted in N leaching and denitrification losses and may have deprived the attainment of higher yield goals.

A 300 bu corn crop will remove approximately 270 lbs of soil N per acre with the harvested grain. As such, split application of N is critical in Michigan because of the potential wet spring conditions. Modern hybrids also take up about 30% of the N after the VT stage, relying on the late season soil N availability.

Soil moisture conditions, however, are largely dependent on local rainfall. Adequate soil moisture is critical for growth and crop yield. Drought conditions interfere with N uptake as roots take up most of the N that is dissolved in the soil moisture. Too much soil moisture early in the season will result in N losses via leaching and denitrification, as evident in 2014 and 2015. The question is, 'Are farmers able to offset this soil moisture variability to a certain extent by relying on climate tolerant hybrids?'

Several mid-western universities have started research to investigate how modern hybrids perform under high population densities and non-limiting N environments.   Due to lack of clear guidelines and consensus at the moment, famers may not be taking full advantages of all the hybrid traits and technological advances at their disposal. A better understanding of how these fundamental factors interact offers the best short term opportunity to educate Michigan farmers to achieve profitability and environmental stewardship. This cutting edge research is quite timely, considering the need to double corn production in 2030 to meet the global demand.

Testing how these hybrids perform under different input levels will provide valuable data to help growers who wish to apply variable rate technology to planting populations and nitrogen rates in the future.

Materials and Methods

The hypothesis we tested was that corn yield and profitability could be increased in the short term by growing climate resistant corn hybrids at non-limiting population densities and N supply. In 2016, three variables; hybrids, population density and nitrogen were included. Two semi-flexed ear type hybrids were used; DKC54-38and DKC55-20, both having herbicide stacked technology and improved drought tolerance capabilities. Two planting populations (32,000 and 36,000 plants per acre) were tested. Two static N rates, 160 lb/A (low) and 240 lb/A (high) were applied, where most of the N was sidedressed d at the V6 stage. In addition to static N treatments, we also included several other N treatments with the emphasis on extending the N sidedress window, as predicted by the web-based Climate Fieldview Pro™ N Advisor model. (see below). This model will track the level and movement of N based on soil type, initial nitrogen application rate, rainfall and other climatic conditions across the entire growing season. It will be a guide to the rate and timing for optimal late-season N applications based on yield target and profit goals. We used a Y-drop system to apply N at V10. The sidedress N applications were made using 28% liquid UAN.

Table 1. Experimental treatments consisting of population and N rate and timing used in 2016

Treatment	Population	At-Planting N 5/19/16	Sidedress V6 6/13/16	Y-Drop V10 7/7/18	N Total
1	32,000	40	120	0	160
2	32,000	40	200	0	240
3	32,000	40	120	120	280
4	32,000	40	200	30	270
5	32,000	120	0	180	300
6	38,000	40	120	0	160
7	38,000	40	200	0	240
8	38,000	40	120	120	280
9	38,000	40	200	30	270
10	38,000	120	0	180	300

In treatment 1 and 2, we applied 40 lbs of N at planting and the balance of N sidedressed at V6. This represents the traditional N practices. In treatments 3 and 4, we took the two previous treatments and added another dose of N at V10, using a Y-drop system. The treatment 5 represents a N scheme that is recommended by a several mid-western universities, where you apply most of your N at planting and at V10.

The planting date was May 19th under ideal weather conditions. The experimental treatments used in 2016 are shown in Table 1.

A randomized block design with Factor A (population) and Factor B (N rate and timing), was used. Treatments were replicated three times for each hybrid. Each plot consisted of 4 rows 180 feet in length. The crop rotation was corn after soybeans. The plots were established on a high productive soil at Mason Technology Center in Mason, MI. The 60 test plots occupied 3 acres of land.

During the season aerial images were taken during V3, V8, VT and R6. Light reflectance images were taken by an unmanned aerial system (drone). Heat radiation images were taken by a low flying aircraft.

Before the harvest end-of season stalk samples were taken for nitrate-N analysis.

Ear samples were taken at harvest to asses yield components. These components include the number of kernel rows per ear, number of kernels per row, and average kernel weight.

The corn was harvested on October 29th. The middle two rows of each plot were harvested and weighed using a special combine. Data was statistically analyzed.

Results are Discussion

- ***Weather conditions in 2016***

The 2016 growing season was dominated by an unprecedented drought starting in late May, June and July (Table 2). We received only 0.9 inches of rain in June and 1.4 inches in July. Most of the N was sidedressd on June 13th . It was not until late July that we received the first significant rainfall event. During June and July both hybrids showed severe leaf rolling symptoms to overcome drought. In August, September and October however we received excess rainfall which made 2016 a wet year statistically.

Table 2. Monthly rainfall at Mason, MI in 2016, 2015 and 2014 compared to the 5-yr Average

Month	Rainfall 2016	Rainfall 2015	Rainfall 2014	5-year Average
April	2.8	1.2	1.3	3.0
May	2.7*	3.0	4.3	3.4
June*	0.9*	7.8	4.0	3.5
July	1.4*	3.2	2.8	3.1
August	7.5	4.4	4.5	4.2
September	6.1	2.8	2.9	3.2
October	4.3	1.7	1.8	2.6
Total	25.7	24.1	21.6	22.7

In 2015 and 2014, we experienced excess rainfall early in the spring favoring soil N losses. That prompted us to plan for late season N treatments in 2016. However this season turned out to be the exact opposite of the two previous years.

In 2016 we had extended periods of dry weather after planting and after sidedress N application. We were concerned about the N uptake in dry soil conditions.

- ***Corn yield in relation population and nitrogen***

The overall summary of yield data for each hybrid is shown in Tables 3 -6. Due to unprecedented drought corn yields were severely reduced in all treatments. Plant population effects were not significant. Although the highest N rate produced a significantly higher corn yield than the lowest N rate, a clear pattern of response to N rate and timing was not evident.

Table 3. Corn yield of two hybrids across populations and N treatments - Mason Technology Center, MI 2016

Variable		**Hybrid 1- DKC55-20 Corn yield (Bu/A)**	**Hybrid 2 – DKC54-38 Corn yield (Bu/A)**
Population density	32,000	178	191
	38,000	184	190
Nitrogen rate	160 lb/A	172 b	182 b
	240 lb/A	182 ab	189 ab
	280 lb/A	181 ab	191 ab
	270 lb/A	183 ab	190 ab
	300 lb/A	186 a	201 a

*Statistically significant at 5% level

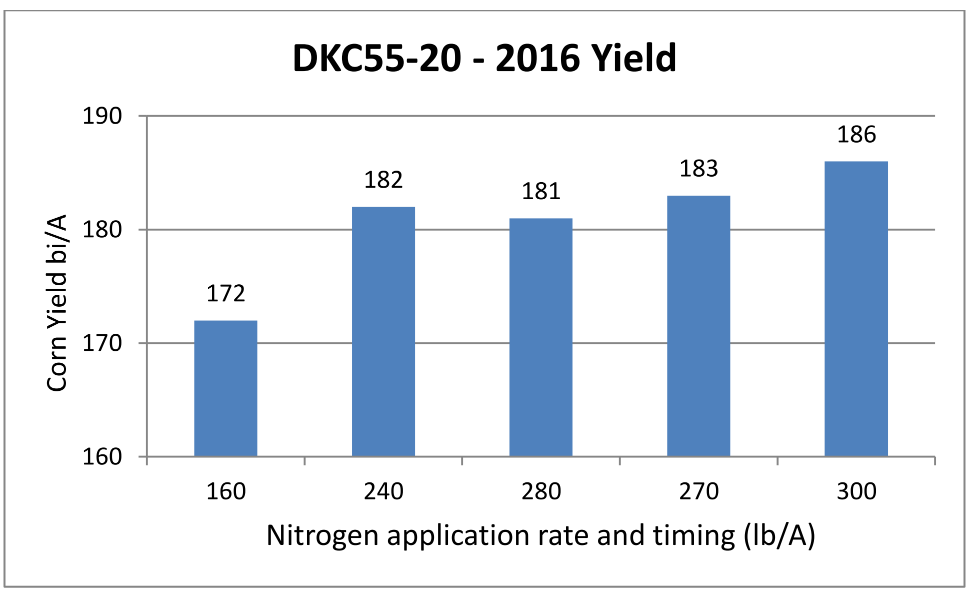
Table 4. Corn yield based on population density and nitrogen rate -Hybrid DKC55-20 Mason Technology Center, MI 2016

Treatment	**Population**	**At-Planting N 5/19/16**	**Sidedress V6 6/13/16**	**Y-Drop V10 7/7/18**	**N Total**	**Yield Bu/A**
1	32,000	40	120	0	160	171.6
2	32,000	40	200	0	240	175.3
3	32,000	40	120	120	280	177.0
4	32,000	40	200	30	270	182.9
5	32,000	120	0	180	300	183.9
6	38,000	40	120	0	160	172.9
7	38,000	40	200	0	240	188.9
8	38,000	40	120	120	280	185.7
9	38,000	40	200	30	270	183.3
10	38,000	120	0	180	300	188.6

Table 4. Corn yield based on population density and nitrogen rate - Hybrid DKC54-38
Mason Technology Center, MI 2016

Treatment	Population	At-Planting N 5/19/16	Sidedress V6 6/13/16	Y-Drop V10 7/7/18	N Total	Yield Bu/A
1	32,000	40	120	0	160	183,1
2	32,000	40	200	0	240	191.7
3	32,000	40	120	120	280	188.1
4	32,000	40	200	30	270	188.7
5	32,000	120	0	180	300	199.6
6	38,000	40	120	0	160	175.9
7	38,000	40	200	0	240	185.6
8	38,000	40	120	120	280	192.9
9	38,000	40	200	30	270	190.3
10	38,000	120	0	180	300	202.8

Table 5. Effect of N treatments on overall corn yield across the two populations



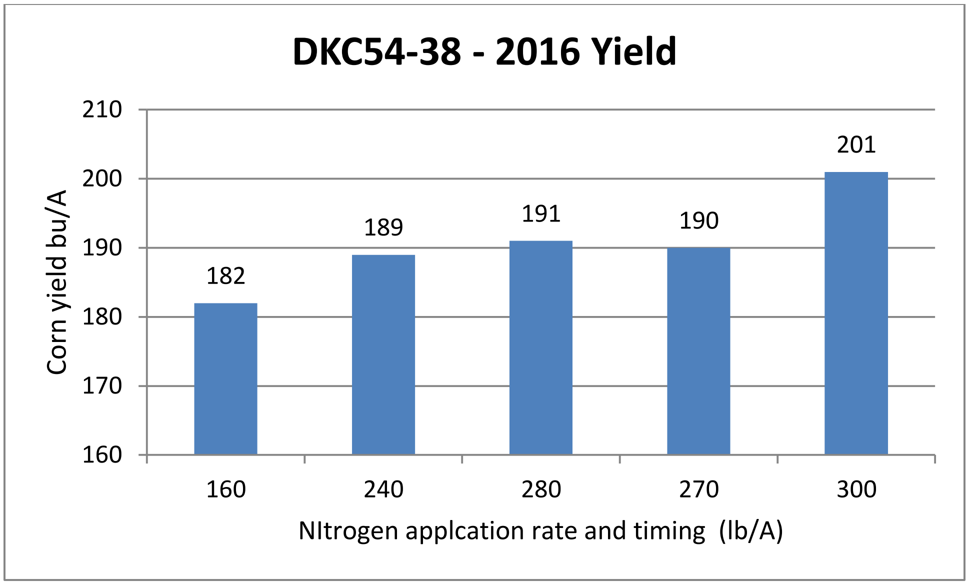
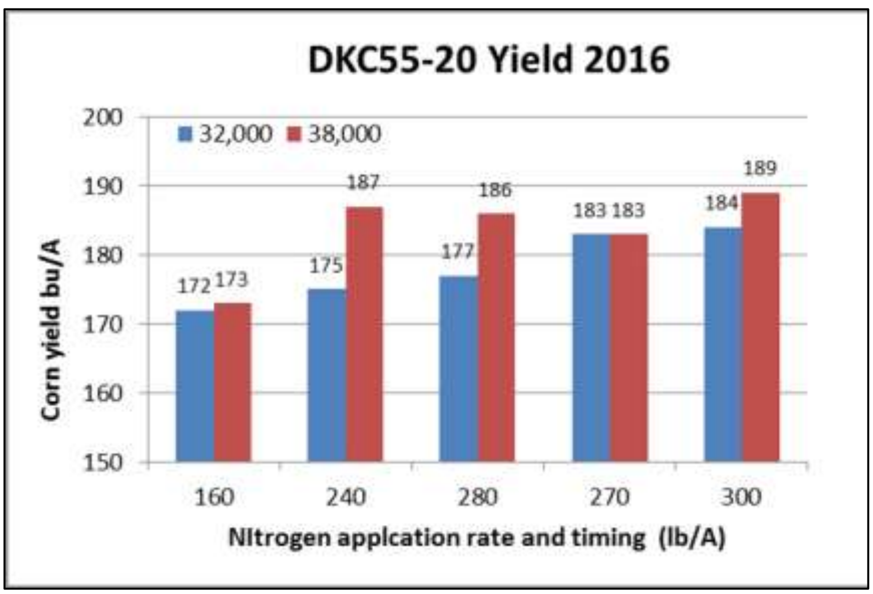
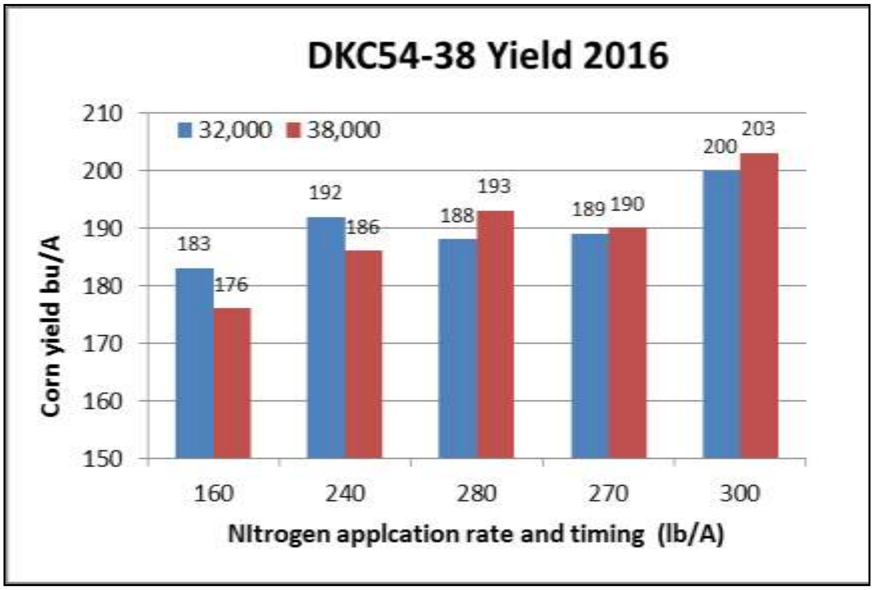


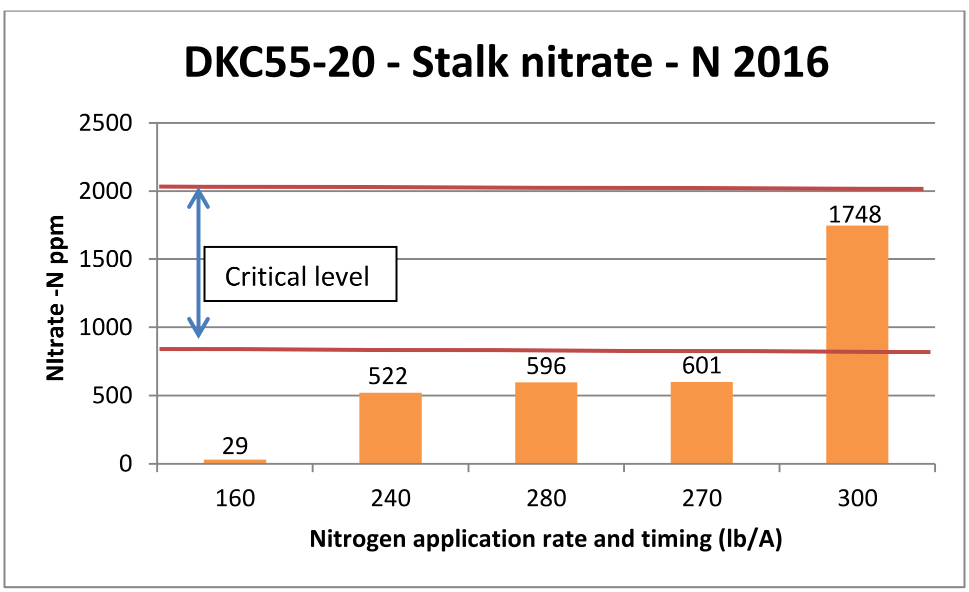
Table 6. Corn yield of two hybrids in 2 populations and 5 N treatments - 2016

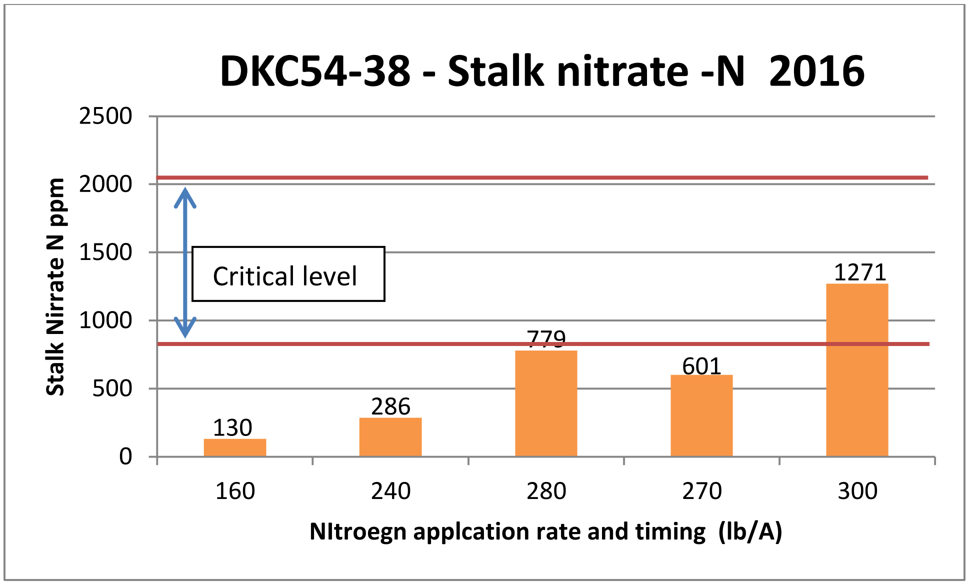




Concerned with the N uptake under dry soil conditions we looked at the data from the end of season cornstalk nitrate test. The stalk nitrate-N levels in most N treatments (Table 7) were below the critical range (700-2000 ppm) indicating that the early drought may have severely impacted the N uptake and thereby reduced yield. Not reaching the critical range means the N was short and not adequate for optimum corn yield, despite the high rates of N applied.

Table 7. End of Season cornstalk nitrate levels of the N treatments of the two corn hybrids in 2016

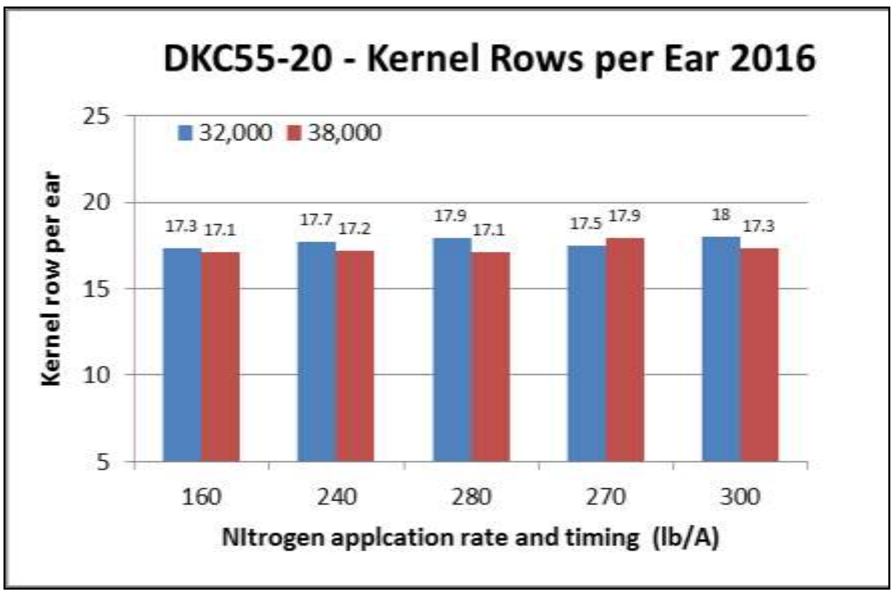


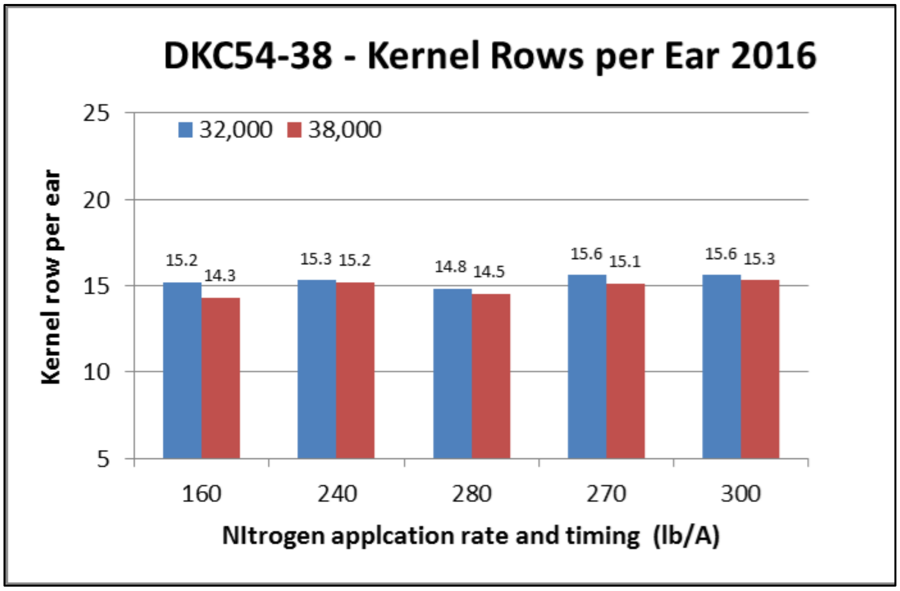

DKC54-38 - Stalk nitrate -N 2016
Stalk Nirrate N ppm
2500
2000
1500
1000
500
0
Critical level
130
286
779
601
1271
160
240
280
270
300
NItroegn applcation rate and timing (lb/A)

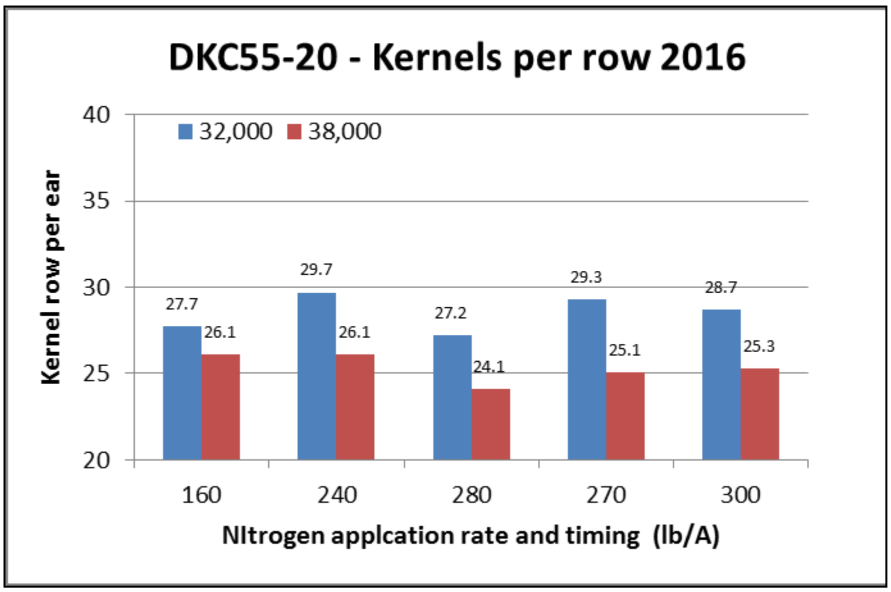

LOW
MARGINAL
OPTIMAL
HIGH
250
700
2000
10,000
CORNSTALK NITRATE
(PPM)

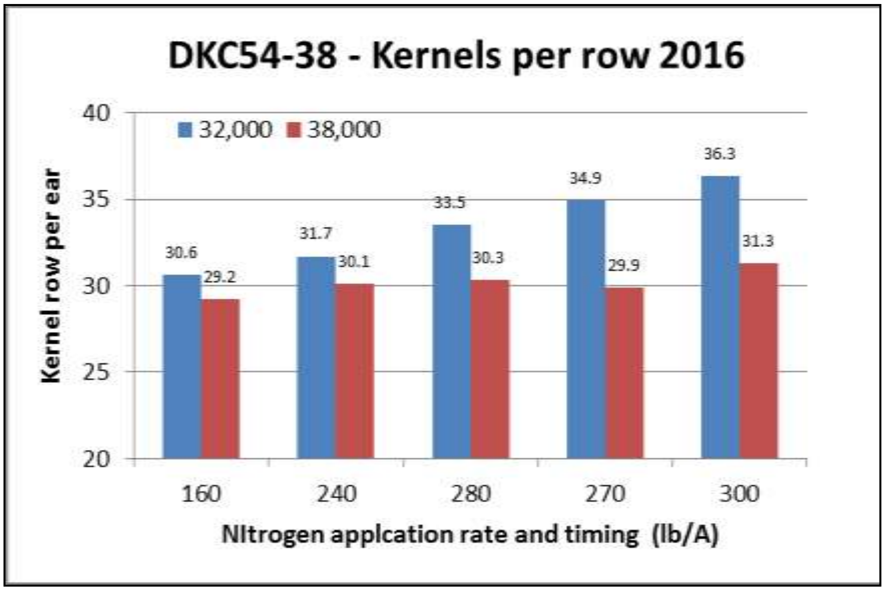
- ***Corn yield components***

We studied the three yield components, kernel rows per ear, kernels per row and average kernel weight. These results are presented below.

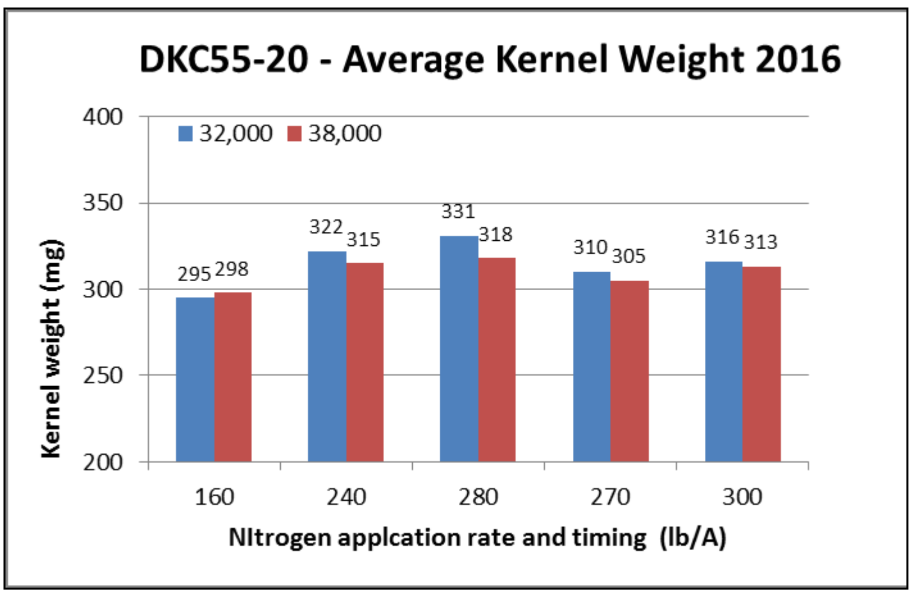



DKC54-38 - Kernel Rows per Ear 2016
32,000
38,000
Kernel row per ear
25
20
15
10
5
15.2
14.3
15.3
15.2
14.8
14.5
15.6
15.1
15.6
15.3
160
240
280
270
300
NItrogen applcation rate and timing (lb/A)

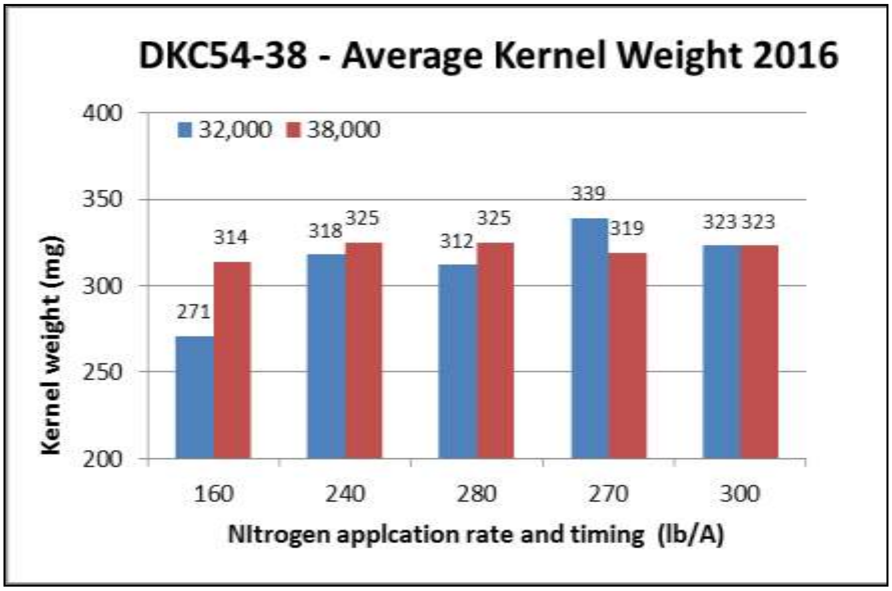

DKC55-20 - Kernels per row 2016
32,000
38,000
Kernel row per ear
40
35
30
25
20
27.7
26.1
29.7
26.1
27.2
24.1
29.3
25.1
28.7
25.3
160
240
280
270
300
NItrogen applcation rate and timing (lb/A)



DKC54-38 - Kernels per row 2016
40
35
30
25
20
32,000
38,000
30.6
29.2
31.7
30.1
33.5
30.3
34.9
29.9
36.3
31.3
Kernel row per ear
160
240
280
270
300
NItrogen applcation rate and timing (lb/A)



DKC55-20 - Average Kernel Weight 2016
400
350
300
250
200
32,000
38,000
295
298
322
315
331
318
310
305
316
313
Kernel weight (mg)
160
240
280
270
300
NItrogen applcation rate and timing (lb/A)



We studied the three yield components, kernel rows per ear, kernels per row and average kernel weight.

The kernel rows per ear showed no response to population and N treatments. There were hybrid differences, however, DKC 55-20 is higher than DKC54-38 by 2 kernel rows per ear.

The kernels per row tend to get reduced as population increased. There were hybrid differences, however, DKC54-38 has about 5 kernels per row higher than DKC55-20.

The average kernel weight showed no response pattern to population and N treatments, although the lowest N rate produced the lowest kernel weight. The average kernel weight was higher in DKC54-38 compared to DKC55-20 indicating a higher test weight.

- ***Aerial imaging***

In 2016, we took preliminary aerial images of our test plots. The images include thermal, AADI, NDVI and HD visual. These preliminary images are currently being processed and interpreted. As the drought was such an overriding factor, we could not readily differentiate N treatments.

- ***Preliminary Conclusions***

The 2016 data should be interpreted with caution. This is especially true for the unusual drought at this location that was not favorable to optimum growth and high corn yield.

The overall objective of this project for 2017 will continue to be the search for best possible N and population combinations to achieve the highest harvestable kernels per acre.

Proposal Impacts:

- This 3-acre research plot served as a tour stop and poster for over 400 visitors for the Monsanto Field day in August 2016 that included Michigan corn growers, private consultants and media personnel. This project attracted a lot of attention and a large number of people expressed interest in seeing our data. There was a lot of interest because it dealt with three fundamental corn production practices, namely hybrid selection, population density and nitrogen management, tools that are currently available to farmers.

- Both Steve Gower and I were present to discuss our research plots with 47 participants at the Fall Conservation Tour Field day in Spetember 2016.

- This project also served as a tour stop for two international groups in August and for 70 corn producers from Ontario, Canada in September, 2016. We promoted the attributes of GMO corn to foreign visitors.

- With the anticipation of other technical breakthroughs within the next few years, namely the release and commercialization of 'Nitrogen-Use-Efficient' hybrids, the N rate X population density X row spacing interactions will attain even more practical significance

- This project also offered an opportunity for MSU Extension educators to stay engaged with Monsanto Co. and other seed companies and their industry leadership role in seed technology advancements. Corn hybrid development is now exclusively handled by private industry.

- This project provided opportunities for MSU Extension educators to promote MSUE fertilizer recommendations and the 4R's concept (right rate, source, timing and placement) for sustainable best fertilizer practices. In intensive cropping systems where higher yields are pursued, inputs will play a key role

- Several other scientists in the corn and soybean North Central states have shared interest and reported preliminary research data and ideas for collaboration in the future. They are interested in finding new ways to provide N late in the season as a way to increase yield. In this respect, they are pursuing slow release N sources and late season N application with high boom Y-drop N applicators.