Corn Marketing Program Report 2015

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

Michigan farmers are increasingly looking for innovative practices to increase corn yield per acre. Corn yields have been increasing in recent years due to a combination of genetic and agronomic factors. Corn yields greater than 300 bu/A have been achieved in sporadic yield contests and regional trials. Some local growers on highly productive soils are reaching 250 bu/A yields on a consistent basis.

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 increase the planting density so more ears and kernels are harvested per acre. At high population 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. As we increase the population rates, however, we are tempted to experiment with 20-inch narrow row spacing compared to the traditional 30-inch spacing. This will provide more even geometric spacing for each plant and lessen the competition within the row. Transitioning to a 20-ich row is a 'paradigm' change because it will involves some new equipment for planting and harvesting.

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, 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 the availability of high productive soils, and adequate nitrogen (N) and soil moisture. Most of the Capac-Marlette soil types in Mid-Michigan have high production potential and are rich in organic matter and CEC. Nitrogen rate, timing, source and placement have critical roles so that N is available when needed and not lost to leaching and denitrification. A 300 bu corn crop will remove approximately 270 lbs of N in the grain. Split application of N is critical because the modern hybrids are reported to utilize more late season N. Soil moisture conditions, however, are largely dependent on local rainfall. The question is, 'Are farmers able to offset this 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 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 timely, considering the need to double corn production in 2030.

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 higher than normal planting densities in narrow row configurations and with adequate N. In 2015, four variables; hybrids, row spacing, population density and nitrogen were included. Two hybrids were used; DKC50-84 (Fixed ear type) and DKC48-12 (Flexed ear type) both having herbicide stacked technology and improved drought tolerance capabilities. Two row spacings, (20-inch and 30-inch) and three population densities (30,000, 36,000 and 42,000 plants per acre) were tested. Two nitrogen rates, 120 lb/A (low) and 240 lb/A (high) were applied. A randomized complete block design for Factor A (row spacing), with Factor B (population density) as a split plot on A, and Factor C (nitrogen rate) as a split plot on B, 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 72 test plots occupied 3 acres of land.

The planting date was April 27th under ideal weather conditions. At planting time 25 lb/A N was applied. The balance of N was applied as a sidedress, injected on June 9th using 28% liquid UAN. Ear samples were taken prior to 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. Following harvest end-of season stalk samples were taken for nitrate-N analysis.

Results are Discussion

- ***Weather conditions in 2015***

The 2015 growing season was dominated by excessive rainfall in June and August (Table 1). In June we received 7.7 inches of rain. Most of this rain came just after we sidedressed the N corn on June 8th. Excess rainfall drowned out portions of the trial in June and August. The wet and soggy soil conditions undoubtedly contributed to denitrification and leaching losses of some portion of the side-dressed nitrogen. Rainfall totals were about 2.9 inches above the 5 year average.

- ***Corn yield in relation row spacing, population density and nitrogen rate***

The overall yield data for each treatment is shown in Table 2. The two hybrids showed similar yield responses to row spacing, population densities and nitrogen rate. The row spacing effects on yield were not statistically significant, but conventional rows performed better than the 20-inch rows. The data offered no compelling reason to transition to a 20-inch system with either of the two hybrids.

Table 1. Monthly rainfall for corn in Mason, MI in 2015 compared to the 5-yr Average

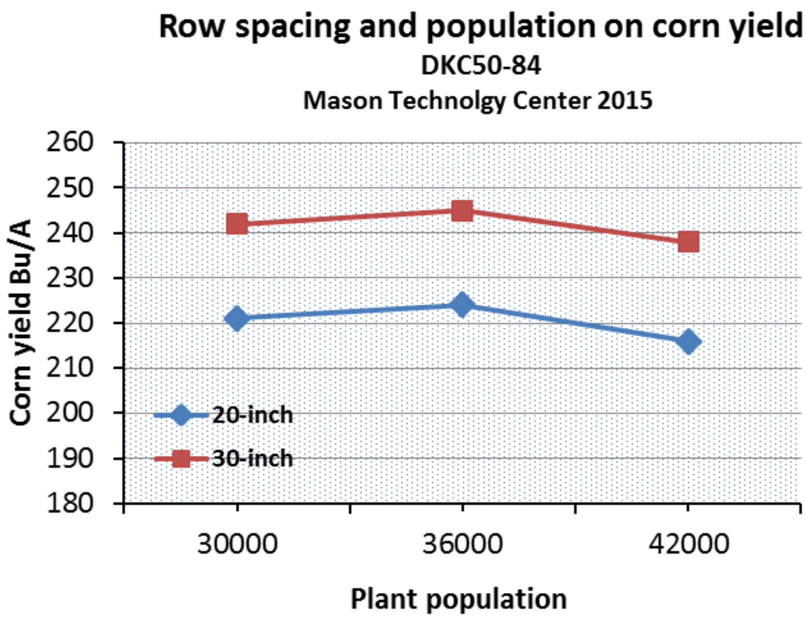
Month	Rainfall	5-year Average
April	1.2	3.5
May	3.6	3.2
June*	7.7	4.0
July	3.2	3.1
August	4.4	3.2
September	2.9	2.6
October	1.7	2.5
Total	**24.7**	**21.8**

Table 2. Effect of row spacing, population density and nitrogen rate on corn yield of two hybrids Mason Technology Center, MI 2013

Variable		Hybrid 1- DKC50-84 Corn yield (Bu/A)	Hybrid 2 – DKC49-72 Corn yield (Bu/A)
Row spacing	20-inch	221b	220
	30-inch	246 a	235
Population density	30,000	232	230
	36,000	237	233
	42,000	228	219
Nitrogen rate	120 lb/A	221 b	211 b*
	240 lb/A	245 a	244 a

*Statistically significant at 5% level

The yield differences amongst the three population rates were not statistically significant. There appeared to be no justification to increase the rate beyond 36,000. The yields tended to decline at 42,000. The row spacing effects at each population are illustrated in Figure 1 and 2.



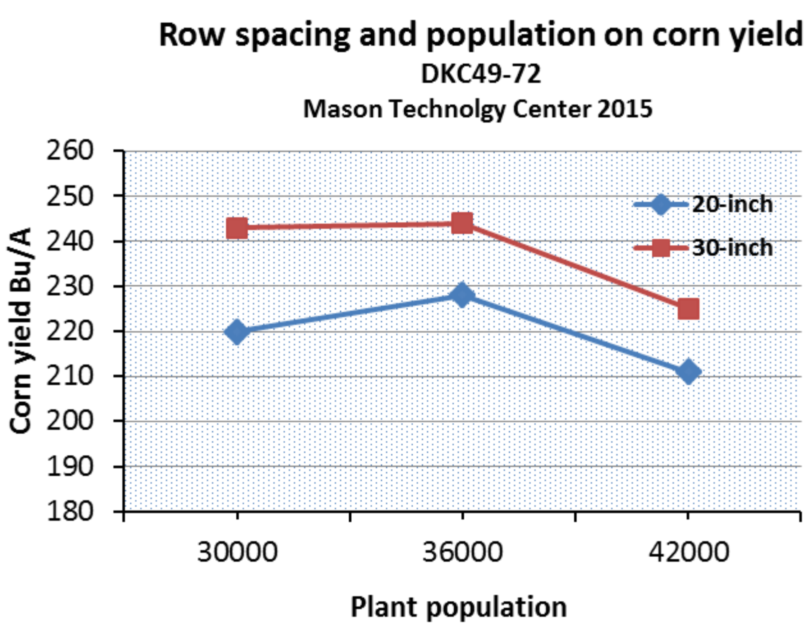
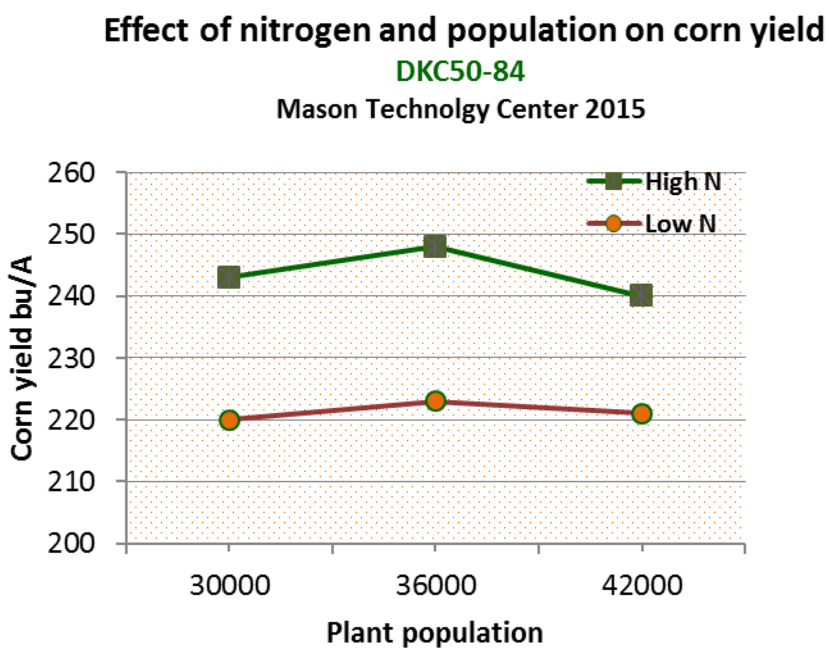


Figure 1 and 2. Row spacing effects on yield at each plant population

Both hybrids produced highly significant yield increases to the higher N rate (Figures 3 and 4). This may be partly attributed to the high rainfall. The heavy early season rainfall may have contributed to significant N losses from denitrification and leaching that may have muted the N response this year.



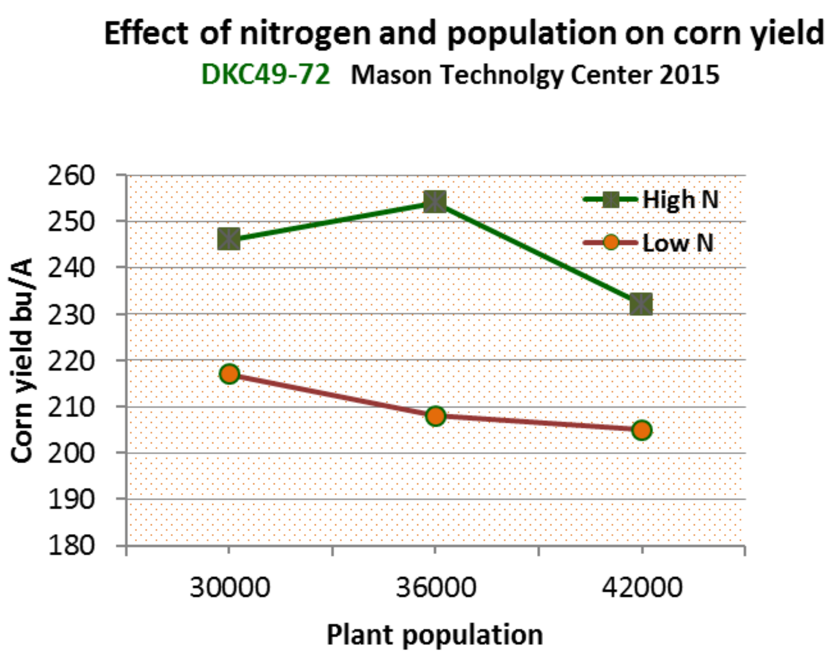


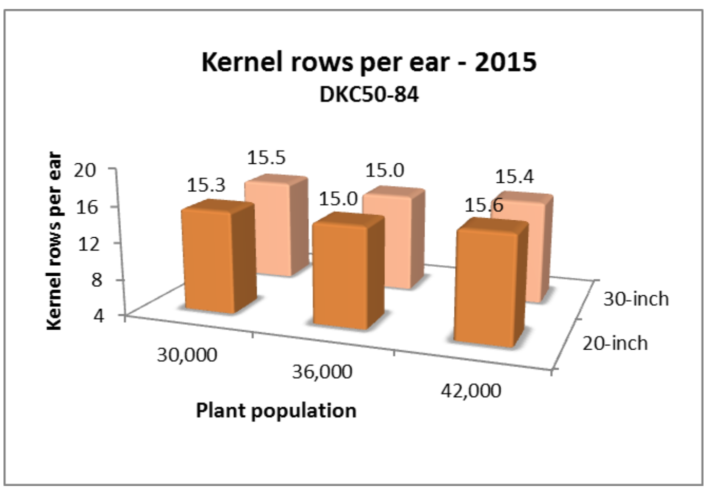
Figure 3 and 4. Nitrogen effects on yield at each plant population

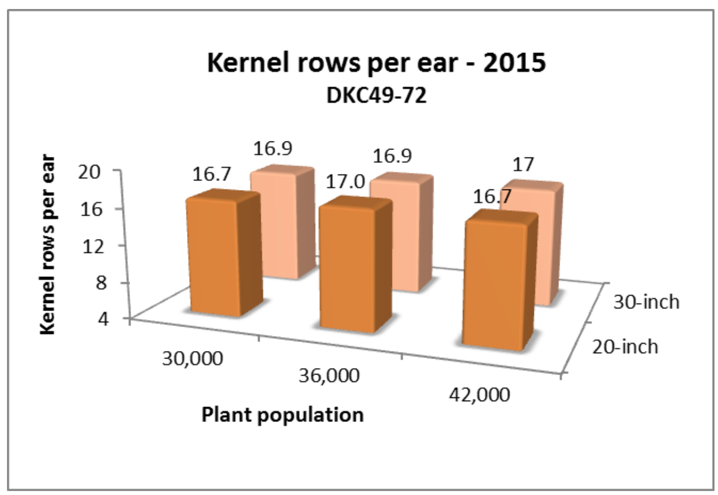
Early firing was observed at the low N treatment on both narrow and conventional row spacing's (Figure 5).

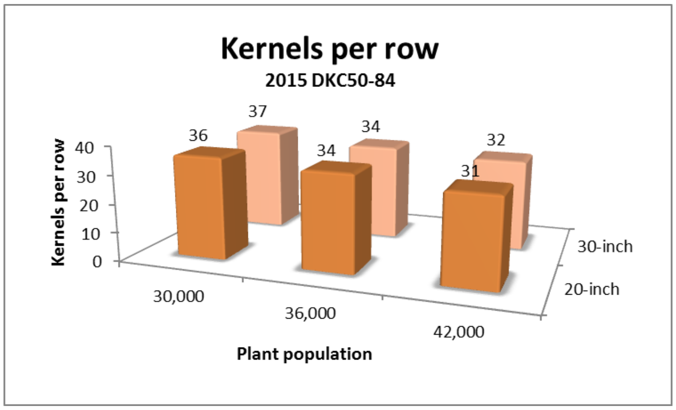
Figure 5. Early Firing on corn

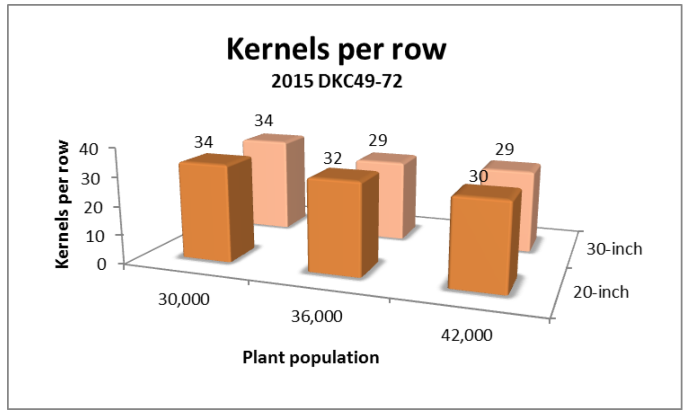
- ***Corn yield components***

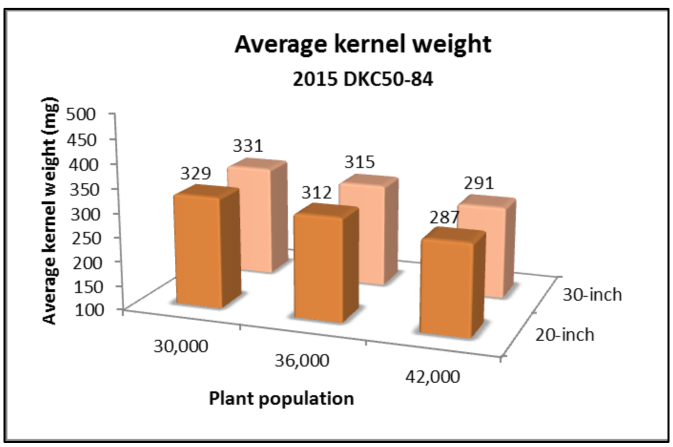
The effects of row spacing and population rate on the kernel rows per ear, number of kernels per row and average kernel weight are illustrated in Figure 6. The effects were more pronounced for the number of kernels per row and average kernel weight (largely late season determinants) rather than kernel rows per ear. Nitrogen rate also showed a similar effect (Figure 7). The number of kernels per row and average kernel weight steadily declined as population density increased and nitrogen rate decreased. The lack of a yield response to the high population rate and the significant yield response to higher nitrogen rate may be partially attributed to this feature.











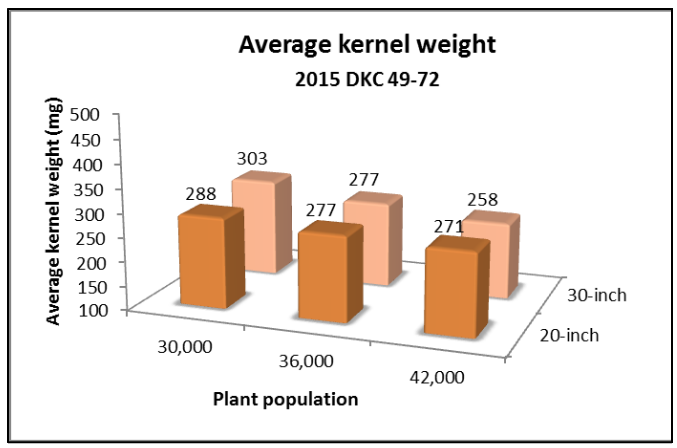
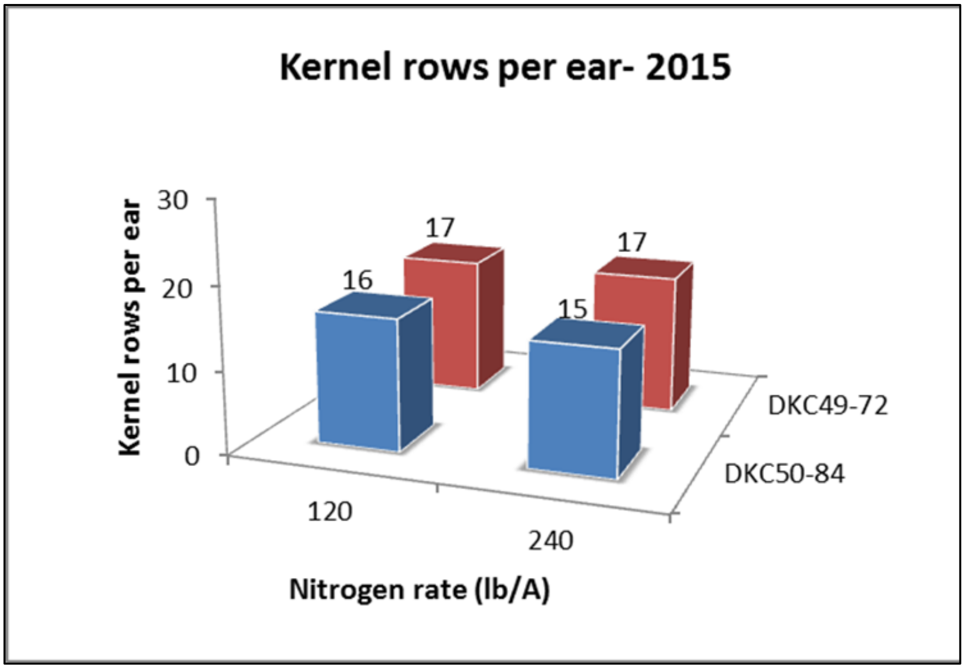
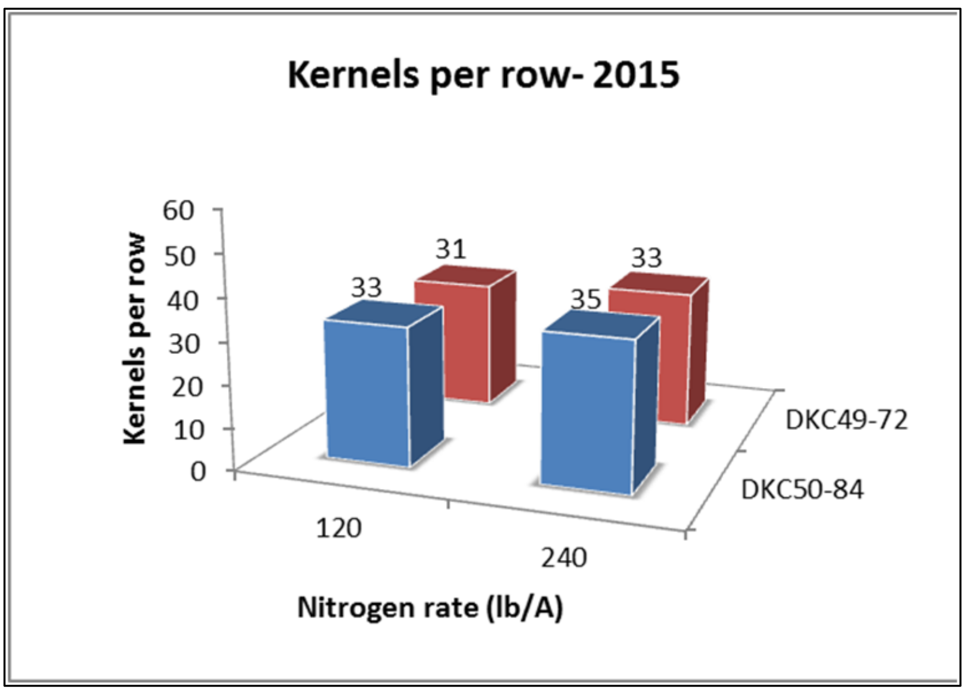


Figure 6. Population and row spacing on yield components – 2 hybrids 2014


Kernel rows per ear- 2015
Kernel rows per ear
30
20
10
0
16
17
15
17
DKC49-72
DKC50-84
120
240
Nitrogen rate (lb/A)


Kernels per row- 2015
Kernels per row
60
50
40
30
20
10
0
33
31
35
33
DKC49-72
DKC50-84
120
240
Nitrogen rate (lb/A)

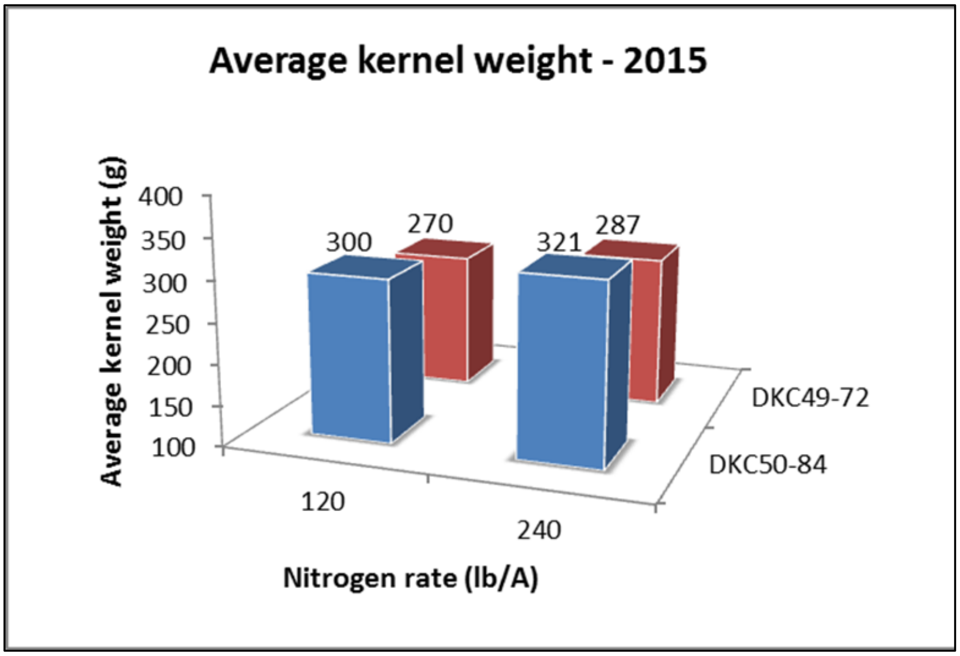


Figure 7. Nitrogen rate on yield components – 2 hybrids 2015

- ***Preliminary Conclusions***

The 2015 data should be interpreted with caution. This is especially true for the unusual weather and growing conditions at this location that was not favorable to growth and corn yield.

In 2015 we attained yields over 250 bu/A on some plots. The excess early season rain drowned out some areas of the field reducing the potential yield. It is conceivable therefore that we may have achieved even higher yields if favorable conditions persisted throughout the season. This data support our view that we need to continue with this research for another year. Also, data on late season ear yield determinants will be considered critical to the interpretation of yield data from hybrids that range from flexed to fixed ear types.

From the 2015 data we could not validate the hypothesis that corn yield and profitability could be increased in the short term by growing new corn hybrids at higher than normal planting densities in narrow row configurations and with adequate N. When we increased the population to 42,000, we harvested more ears per acre, but these ears had fewer kernels per row and reduced kernel weights. It appears that growing conditions also need to be satisfactory for these hybrids to perform well on narrow rows and high populations.

The overall objective of this project for 2016 will continue to be the search for best possible treatment combinations to achieve the highest harvestable kernels per acre. Because the narrow row treatment has not consistently produced higher yields compared to traditional 30-inch spacing in the first two years, we will not pursue narrow row treatment in 2016. Instead, we will add a third N treatment using Field View Pro and Adapt-N models which will take into consideration in-season rainfall in May, June and July and other growing conditions including soil type to decide on the optimum N rate.

We will also add high resolution multispectral imagery to monitor crop health in all our treatments.

Proposal Impacts:

- This 3-acre research plot served as a tour stop for 85 visitors that included Michigan corn growers, private consultants and media personnel. Both Steve Gower and I were present to discuss our research objectives. 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 four fundamental corn production practices, namely hybrid selection, row spacing, population density and nitrogen management, tools that are currently available to farmers.
- This project also served as a tour stop for two international groups in August and for 70 corn producers from Ontario, Canada in September, 2015
- 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 appropriate soil and tissue N diagnostic tests at the soil academy. Also, we promoted 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.
- The 20-inch row system leaves a lot of biomass on the ground following harvest. There is a residue management issue to reckon with. Part of this residue could be removed for other uses without affecting the total reside cover desired. This residue if allowed to decompose will consume a lot of soil N in the process of bacterial breakdown.