

Characterization of Corn Hybrids in Response to Nitrogen Fertilizer, Plant Population, Foliar Fungicides and their Interactions.

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2013 Progress Report prepared for International Plant Nutrition Institute, Pioneer Hi-Bred, Syngenta Seeds, and Ontario Agribusiness Association.

Date: January 14, 2014

Expected Project End Date: March 31, 2015.

Support for 2012 and 2013 was gratefully received from Pioneer Hi-Bred International, International Plant Nutrition Institute (IPNI), Ontario Agribusiness Association (OABA), and Syngenta Canada.

1. Introduction:

- Recent surveys have indicated that Ontario corn growers are asking for hybrid-specific management information as a top priority, in addition to yield performance data produced from the public performance trials. The latest poll was surveyed at the Southwest Ag Conference in 2013, where over 70% of growers (n=450) ranked hybrid-specific management as a top priority or need through corn research/extension.
- Small-plot and field studies in Ontario have shown yield response to corn hybrid, population, fungicides and nitrogen. These are *the* major agronomic factors in modern corn production. Previous research in Ontario has shown grain yield increases of 50 bu/ac with a fungicide application, but the average response is less than 6 bu/ac. Nitrogen is also very important to both the economics of producing corn and impacts on the environment. Recent observations indicate that hybrids have differential nitrogen use efficiencies (NUE), but little is known on the magnitude of these differences with current top hybrids. The physiological basis of differential responses amongst hybrids is poorly understood and needs further investigation. Higher NUE may be partly associated with extending green leaf area; foliar fungicides tend to extend green leaf area in corn, therefore, fungicides may increase NUE.

2. Main Objective:

- 2.1. To characterize the response of corn hybrids with different genetic backgrounds to several agronomic variables that includes nitrogen, population, foliar fungicide, and their interactions.

3. Research Questions:

- 3.1. Does the response to N rate depend on plant population and hybrid (or phenotypic traits)?
- 3.2. Does the response to N rate depend on whether a foliar fungicide was applied at tasseling, and does this response depend on the hybrid (or phenotypic traits)?
- 3.3. Does the response to N vary with plant population or whether a foliar fungicide was applied at VT in a stand planted at a high population?
- 3.4. When yields were affected by nitrogen, plant population, and foliar fungicides what were the main physiological components affected?

4. Methodology

- Six hybrids (Table 1a) were planted following soybean on 30 April 2013 and 5 May 2014 in a split-split-split plot design with 4 or 5 replications at the Ridgetown Campus, University of Guelph, Ridgetown, Ontario, Canada, on a loam soil. The same hybrids were planted in both years. The main plot was seeding rate 80,000 vs 110,000 seed/ha (32,000 and 44,000 plants/ac), the first split was foliar fungicide (with and without fungicide); the second split was N rate at 0, 130, 200, and 270 kg N/ha (0, 120, 180, and 240 lbs N/ac), and the third split was hybrid. Final populations were within 5% of the seeding rates and were similar among hybrid, population, nitrogen, and fungicide treatments. Corn was planted at a depth of 4-cm (1-1/2") using a John Deere 7000 planter with a row spacing of 0.76 m (30"). A starter fertilizer of 150 kg/ha (135 lbs/ac) of 8-32-16 was applied to all plots; starter was banded 5 cm below and 5 cm to the side of seed at planting with Ausherman fertilizer coulters. Hybrids were recommended by Pioneer Hi-Bred and NK Seeds to represent a range of tolerance to drought stress and susceptibility to leaf diseases that are common in Ontario (Table 1). The same plant populations were suggested as CMRA protocols in the United States. Nitrogen was applied at V2-V3 as UAN (28-0-0) using a custom-designed applicator for variable rate application. UAN was knifed-in between crop rows at approximately 12 cm deep. Fungicides were applied on one date when the latest hybrid to silk was at VT; in both years, the earliest hybrid silked approximately 8-9 d prior to application (see Table 1a for the range of silking dates). The fungicide QUILT™ was

applied to the NK hybrids, and ACAPELA™ (picoxystrobin) was applied to the Pioneer hybrids at recommended use rates. Fungicides were applied at a spray volume 15.0 US gallons per acre using a JD 4760 commercial row crop sprayer using flat fan nozzles.

- The measurements performed are presented in Table 1b. Please note that per-plant samples for N and dry matter from 2012 and 2013 (points 15 and 16 in Table 1b) are currently being processed as a winter activity; results for N and dry matter harvest indices should be available shortly.

Table 1a. Corn hybrid maturities and fungicides employed in the multifactor corn hybrid nitrogen population fungicide project at Ridgetown, ON, 2012 and 2013.

Company	Hybrid	Fungicide Strategy at VT-R2	Relative Maturity (days)	Silk RM (days)	Black Layer RM (days)	Ontario CHU Rating
NK Brand	A	Quilt	86	88	86	2675
NK Brand	B	Quilt	92	93	93	2800
NK Brand	C	Quilt	101	101	102	3050
Pioneer	D	Acapela	100	100	99	3000
Pioneer	E	Acapela	102	107	108	3100
Pioneer	F	Acapela	104	102	104	3150

Note: Permission to publish hybrid names will be requested from seed companies after 3 years of the study.

Table 1b. Measurement listing for the multifactor corn trial at Ridgetown, ON in 2012 and 2013.

STAGE		MEASUREMENT	REPS	Hybrids	N*	POP	Fung	SAMPLES OR PLOTS per year
multifactor		total number of units --->	5	6	4	2	2	480
1	anytime	soil sample- basic test	5	1	1	1	1	5
2	anytime after VT	Final Stand	5	6	4	2	2	480
3	VT	Date of 50% pollen shed	5	6	4	2	2	480
4	VT	Date of 50% silk emerge	5	6	4	2	2	480
5	VT	foliar disease ratings at VT	5	6	4	2	2	480
6	R2	SPAD	5	6	3	2	2	360
7	R3-R4	tissue tests @ R4	4	6	3	2	2	288
8	R4	foliar disease ratings at R4	5	6	4	2	2	480
9	R4-R5	SPAD	5	6	3	2	2	360
10	R6	Date of 50% black layer	5	6	4	2	2	480
11	R6	plant height	5	6	4	2	2	480
12	R5-R6	stay green	5	6	4	2	2	480
13	R6	plant vegetative dry matter @ R6	4	6	3	2	2	288
14	R6	total row length of hand harvested plants	4	6	3	2	2	288
15	R6	N analysis of vegetative DM after grinding	4	6	3	2	2	288
16	R6	hand-harvested plants grain weight	4	6	3	2	2	288
17	R6	hand-harvested plants grain MC	4	6	3	2	2	288
18	R6	seed yield (plot)	5	6	4	2	2	480
19	R6	Lodging (%)	5	6	4	2	2	480
20	R6	hundred seed weight	4	6	3	2	2	288
21	R6	test weight	5	6	4	2	2	480
22	R6	% oil	4	6	3	2	2	288
23	R6	% protein	4	6	3	2	2	288

*All 3-N tmt measurements in 0, 120, 240

5. Preliminary Results

Weather. Briefly, the number of accumulated GDD or Ontario Corn Heat Units (OCHU) was slightly above normal for 2012 and slightly below normal for 2013 growing seasons at Ridgetown, Ontario, Canada (data not shown). Emergence was excellent with timely rainfall events after planting. In 2012, corn plants were visually drought stressed in a 3-week period that ended approximately 7 days after VT stage of crop development, on average, across hybrids. Timely rains occurred from this stage of corn development to maturity. In 2013, soil moisture did not limit growth until after silking; precipitation was below normal for the months of August and September.

Leaf disease. Northern leaf blight, eyespot, and rust are the predominate leaf diseases to infect corn in Ontario. In both 2012 and 2013 at this site however, leaf diseases were relatively low throughout the duration of the grain fill period (<5% green leaf area of the upper canopy infected). As a result, leaf disease data are not presented.

Grain yield. Grain yields varied between 101 and 263 bu/ac depending on the hybrid-treatment combination and year (Tables 2a and 2b). The effect of hybrid on yield, moisture content at harvest, lodging, oil, protein, starch were all highly significant (Table 3; $p < 0.001$). More noteworthy, however, was that the response of hybrid depended on the population and the rate of nitrogen; these differences resulted in highly significant Hybrid x Nitrogen and Hybrid x Population interactions during both years (Table 3). For instance, in 2012, “Hybrid E” had the lowest yield with no N applied sidedress (approximately 20 bu/ac lower than any other hybrid; Table 2), but the same hybrid resulted in the highest yield of all hybrids at the highest rate of nitrogen sidedressed (more than 20 bu/ac higher than any other hybrid; Table 2). In this hybrid in 2013, the delta yield response to N was less than 2012, but was among the highest among hybrids. In 2012, “Hybrid B” had the highest yield with zero N at 155 bu/ac, but yielded 225 bu/ac at the highest N, which equates to a delta yield of 70 bu/ac. In 2013, this hybrid was also one of the highest yielding with zero fertilizer N, but similar to 2012, the yield response to fertilizer N was less than other hybrids.

Grain yield response to population was also dependent on hybrid, which produced a Hybrid x Population interactions in both years (Table 3; $p < 0.0001$). Averaged across hybrid and years, increasing plant population from 32,000 to 42,000 plants/acre resulted in an average yield increase of 10 bu/ac, but this was not statistically significant (Figure 2; $p > 0.05$). However, some hybrids did respond more favorably to extremely high populations. For example, grain yield of Pioneer “Hybrid E” was 25 bu/ac higher with 42,000 plants/ac compared to 32,000 plants/ac across years (Table 2 and Figure 2; $p < 0.05$).

In 2012, the response to sidedressed nitrogen depended on the population, which produced a highly significant Nitrogen by Population interaction (Table 3; $p = 0.003$); however, there was no interaction in 2013. Perhaps the lower yield response to fertilizer N in 2013 failed to produce the interaction with population. However, when the data were averaged across 2012 and 2013, the N x population interaction on grain yield was statistically significant ($p < 0.05$). When averaged across hybrid and year, increasing nitrogen rates from 120 to 180 or 240 lbs/ac increased grain yields by 11 bu/ac ($P < 0.05$) at the 32,000 plants/ac, but at the high population of 42,000 plants/ac, grain yields increased by 19 bu/ac ($P < 0.05$) when nitrogen rates increased from 120 to 180 or 240 lbs/ac averaged across hybrids (Figure 2). Even though the 3-way interaction among hybrid, nitrogen rate, and population was weak (Table 2;

$p > 0.05$), when averaged across years, “Hybrid A” responded to the combination of high N and high population (13 bu/ac; $p < 0.05$) but “Hybrid E” showed a much larger yield response of 34 bu/ac (Figure 2; $p < 0.0001$). In 2012, drought stress was evident with leaf rolling of “Hybrid A” at approximately 10 d after VT, compared to little visual stress (leaf rolling) at approximately 2 d after VT on the same calendar date (Figure 3).

Foliar fungicides applied between VT and R2 did not affect yield when averaged across other treatments, and there were no interactions. On average, fungicide-treated plots yielded 3 bu/ac more than the untreated plots ($p > 0.10$).

Harvest Moisture. Moisture content at harvest varied among hybrids; in 2012 for example, average harvest moisture content increased from 18.3% with zero N sidedressed, to 19.3% at 180 lbs N/ac (Table 5a). Only two of the six hybrids produced higher harvest grain moisture contents with 42,000 plants/ac compared to 32,000, which caused a significant Hybrid by Population interaction (Table 3; $p = 0.02$).

SPAD Meter. Nitrogen rates strongly influenced ear-leaf chlorophyll concentrations (SPAD) in both years, with highest readings at the highest N rates when averaged across hybrid (Tables 6a and 6b). There was an interaction between nitrogen and fungicide at the R4 readings in 2012, but no evidence of an interaction in 2013. Across all hybrids in 2012, the earliest-maturing “Hybrids A and B” produced the highest SPAD meter readings, especially using N rates of 180 or 240 lbs N/ac ($p < 0.05$ contrast not shown; Tables 6a). There were fewer SPAD differences among hybrids and N rates in 2013, which correlates to a lower yield response to fertilizer N in 2013 compared to 2012.

Anthesis-silking interval (ASI). The ASI was estimated in days. Data are not presented. Averaged across years, “Hybrid D” tended to have the longest ASI of 2.1 days compared to zero ($p = 0.05$) and “Hybrid E” had the shortest ASI of 0.4 days ($p > 0.10$; data not shown). Averaged across all hybrids, increasing population from 32,000 plants/ac to 42,000 plants/ac tended to increase ASI, which was expected ($p < 0.05$; data not shown).

Stay green. Staygreen (estimated portion of leaf area green during late grain fill) was highly influenced by hybrid, N rate, population, and fungicide in both years (data not shown). There was a strong trend for higher staygreen with increasing rates of nitrogen or with the application of a foliar fungicide after VT (data not shown).

Plant height. Plant height was different among hybrids, and was lower in the 0 N rate than the other three N rates (data not shown). On average, plant height at the 42,000 plants/ac population was 3.3-4% lower than at 32,000 plants/ac averaged across years ($p = 0.05$; data not shown).

Lodging. Lodging was near zero in the two early hybrids (“Hybrids A and B”; data not shown), but lodging was moderate in the later hybrids just before harvest because of stormy weather after the early hybrids were harvested (Tables 7a and 7b). Lodging was influenced by hybrid, N rate, and population in both years (Table 3). Lodging near harvest tended to increase with nitrogen rates and plant population, but the increase was also dependent on the hybrid, which caused 2 or 3-way interactions (Table 3).

Corn quality. Oil, protein, and starch concentrations depended on hybrid and N rate ($P < 0.0001$) during both years; however, the responses with each factor were highly dependent on each other, producing

highly significant interactions (Table 3, Tables 8a,b-10a,b). Oil in the grain tended to increase with N rates in hybrids that responded the most in yield to N fertilizer in 2012, but the opposite trend occurred in 2013 (Tables 8a and 8b); these responses need further investigation. Grain protein increased with fertilizer N in both years (Tables 9a and 9b); the response depended on the hybrid, with trends that appear consistent across years. Fertilizer N tended to decrease the amount of starch in the grain during both years, but the response varied by hybrid. The hybrid-specific responses appear to be relative consistent across years. Across hybrids, the application of a fungicide increased starch content in both years (Tables 10a-b).

Other measurements. These included date of physiological maturity, dry matter per plant at maturity for determination of harvest index (HI), nitrogen in the stalk per plant at maturity for determination of nitrogen harvest index (NHI), grain quality (protein and oil), and grain yield components (seed weight, number of kernels per ear). Preliminary analysis of harvest index shows hybrids that are most responsive to management are those with higher harvest indices, compared to hybrids that tend to be relatively non-responsive to high populations, N, and fungicide. Much of the N data are in process of collection from samples in storage.

6. Preliminary Summary

It is important to note that the results presented are only from two environments (2 site-years). In both years, the 6 hybrids chosen for the study were characterized in response to nitrogen, population, fungicides, and their interactions. Differential hybrid responses occurred during both years, with high rates of nitrogen and higher populations, independently and in combination with each other. Averaged across hybrid and year, grain yields responded to nitrogen especially at the highest plant population. More importantly however, hybrids responded differently to nitrogen, population, and the interaction between nitrogen and population. A population increase from 32,000 plants/ac to 42,000 plants/ac produced yield responses that varied between 7 to 34 bu/ac depending on the hybrid and year. Response to an increase of nitrogen from 120 to an average of the 180 and 240 lbs N/ac varied from 10 and 35 bu/ac depending on the hybrid and year. Response to a combination of high nitrogen and high population varied from 13 to 34 bu/ac, depending on the hybrid when averaged across years. The hybrid that responded the most to higher population and nitrogen showed greater drought tolerance during a water deficient at VT, and a lower ASI, compared to other hybrids, during both years. In this study, yields did not respond to a foliar fungicide applied after VT at 32,000 plants/ac and 120 lbs N/ac in most hybrids, and there was no response to fungicide when combined with high rates of nitrogen and/or high populations. Differential fungicide responses with hybrid were expected based on previous research due to the control of disease on susceptible hybrids; the environment during both years was not favorable for leaf disease in this study, which may explain the lack of response due to fungicide.

Table 2a. Grain corn yield at harvest as affected by N rates, fungicide, and population at Ridgely, 2012.

Hybrid	N Rate (lbs/ac)	32,000 ppa				42,000 ppa			
		UTC		Fungicide		UTC		Fungicide	
Grain Yield (bu/ac @ 15.5% Moisture)									
"Hybrid A"	0	129.3	cd	135.0	cd	124.1	d	154.6	bc
	120	180.6	ab	183.2	a	187.7	a	192.0	a
	180	187.9	a	187.2	a	200.8	a	199.3	a
	240	193.8	a	194.2	a	197.8	a	201.6	a
"Hybrid B"	0	147.2	cd	168.5	c	139.6	d	147.4	cd
	120	207.0	b	218.3	ab	214.6	ab	214.6	ab
	180	221.0	ab	212.6	ab	230.5	ab	223.4	ab
	240	220.5	ab	220.8	ab	230.0	ab	237.2	a
"Hybrid C"	0	149.7	d	148.7	d	136.0	d	148.5	d
	120	206.3	bc	211.3	abc	219.1	abc	210.8	abc
	180	203.1	bc	192.7	c	211.4	abc	225.3	ab
	240	221.1	ab	205.6	bc	235.3	a	230.9	ab
"Hybrid D"	0	133.2	d	138.4	d	124.0	d	136.3	d
	120	198.9	abc	199.0	abc	190.8	c	209.6	abc
	180	207.1	abc	183.5	c	203.3	abc	206.5	abc
	240	218.6	ab	197.7	bc	224.2	ab	226.5	a
"Hybrid E"	0	101.0	f	127.1	ef	133.3	e	133.1	e
	120	197.9	d	210.3	d	227.9	bcd	239.3	abc
	180	209.7	d	217.7	cd	261.1	a	251.0	ab
	240	237.5	abc	224.5	bcd	263.0	a	257.0	a
"Hybrid F"	0	152.4	b	135.5	b	144.1	b	150.1	b
	120	218.1	a	216.2	a	221.6	a	228.4	a
	180	230.3	a	216.4	a	235.6	a	233.7	a
	240	225.9	a	231.2	a	242.9	a	237.6	a

Means with the same letter within hybrid are not different ($p=0.05$).

Table 2b. Grain corn yield at harvest as affected by N rates, fungicide, and population at Ridgely, 2013.

Hybrid	N Rate (lbs/ac)	32,000 ppa				42,000 ppa			
		UTC		Fungicide		UTC		Fungicide	
Grain Yield (bu/ac @ 15.5% Moisture)									
“Hybrid A”	0	153.4	f	155.2	f	146.2	ef	167.0	def
	120	183.9	bcd	196.3	bcd	179.9	abc	193.1	abc
	180	178.6	cd	191.5	abcd	185.2	abc	206.7	a
	240	177.3	cde	192.3	abcd	184.7	abc	201.4	ab
“Hybrid B”	0	170.0	c	167.6	c	169.2	c	183.5	bc
	120	206.7	ab	208.6	a	205.2	ab	202.8	ab
	180	205.2	ab	204.2	ab	213.8	a	212.1	a
	240	203.2	ab	204.3	ab	215.0	a	212.7	a
“Hybrid C”	0	163.1	d	157.5	d	171.0	d	178.2	cd
	120	205.6	ab	208.0	ab	204.5	ab	210.7	ab
	180	206.3	ab	198.9	bc	221.3	ab	223.3	a
	240	212.1	ab	202.1	ab	213.3	ab	222.6	a
“Hybrid D”	0	166.5	b	158.0	b	152.8	b	159.9	b
	120	213.9	a	220.0	a	214.0	a	216.6	a
	180	223.3	a	224.6	a	226.4	a	226.5	a
	240	222.4	a	216.6	a	226.0	a	227.5	a
“Hybrid E”	0	178.9	d	165.4	d	182.1	d	164.8	d
	120	220.4	c	228.8	abc	225.2	abc	232.6	abc
	180	227.2	abc	228.0	abc	236.8	abc	246.1	a
	240	222.2	bc	222.5	bc	237.8	abc	243.9	ab
“Hybrid F”	0	171.7	c	168.7	c	177.0	c	166.7	c
	120	210.4	b	231.3	ab	216.4	ab	228.3	ab
	180	217.2	ab	224.8	ab	231.1	ab	231.6	ab
	240	217.5	ab	231.0	ab	230.4	ab	238.1	a

Means with the same letter within hybrid are not different (p=0.05).

Table 3. ANOVA by of multifactor corn hybrid-nitrogen-population-fungicide project at Ridgetown, 2012 and 2013.

Fixed Effect	Lodging	Yield	Moisture	SPAD	Oil	Protein	Starch
2012	Type 3 Test of Fixed Effects (p>F)						
Hybrid	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
Fungicide	0.3185	0.7659	0.3509	0.2016	0.529	0.4144	0.0381
N Rate (N)	0.0062	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
Population	0.0067	0.1741	0.1202	0.1246	0.3872	0.045	0.0138
Hybrid*Fungicide	0.4902	0.7207	0.4686	0.635	0.5208	0.8068	0.8665
Hybrid*N	<.0001	<.0001	0.2828	0.1333	<.0001	<.0001	0.0014
Hybrid*Population	<.0001	0.0005	0.0213	0.794	0.8598	0.6598	0.944
Fungicide*N	0.7813	0.0175	0.7657	0.0793	0.7339	0.2539	0.6788
Fungicide*Population	0.1162	0.5121	0.2681	0.4822	0.1718	0.7149	0.5823
N*Population	0.057	0.003	0.6547	0.9709	0.4286	0.629	0.7131
Hybrid*Fungicide*N	0.9449	0.9451	0.6313	0.6569	0.9414	0.3119	0.9674
Fungicide*N*Pop	0.5706	0.9035	0.2201	0.4046	0.7181	0.7172	0.6584
Hybrid*Fungicide*Pop	0.0024	0.2588	0.6978	0.4595	0.9725	0.0729	0.7299
Hybrid*N*Population	0.0239	0.9735	0.8802	0.7927	0.434	0.9522	0.8844
Hybrid*Fungicide*N*Pop	0.6924	0.8797	0.5776	0.4554	0.2694	0.4179	0.1805
2013							
Hybrid	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
Fungicide	0.8586	0.1706	0.1231	0.9814	0.1569	0.4506	0.0448
N Rate (N)	<.0001	<.0001	0.1795	<.0001	<.0001	<.0001	<.0001
Population	0.0049	0.4065	0.546	0.5902	0.1646	0.0155	0.0001
Hybrid*Fungicide	0.7494	0.0485	0.4378	0.0239	0.3607	0.2394	0.942
Hybrid*N	0.0004	<.0001	0.7667	0.0001	<.0001	<.0001	<.0001
Hybrid*Population	<.0001	0.0003	<.0001	0.3653	<.0001	<.0001	0.0001
Fungicide*N	0.8962	0.4941	0.4301	0.9244	0.9791	0.9811	0.9864
Fungicide*Population	0.2406	0.6826	0.4639	0.6429	0.875	0.8743	0.3928
N*Population	0.0145	0.8193	0.0156	0.9749	0.3502	0.6265	0.3956
Hybrid*Fungicide*N	0.9803	0.8882	0.8687	0.6892	0.4192	0.9077	0.2862
Fungicide*N*Pop	0.8967	0.9387	0.5572	0.9372	0.2506	0.7937	0.2002
Hybrid*Fungicide*Pop	0.5674	0.1781	0.0671	0.0348	0.0386	0.5435	0.1698
Hybrid*N*Population	0.1254	0.2131	0.7491	0.6929	0.2826	0.0212	0.7096
Hybrid*Fungicide*N*Pop	0.9635	0.9858	0.9938	0.0342	0.5048	0.9259	0.7097

Table 4. Average grain corn yields at harvest as affected by hybrid and N rates across fungicide and plant populations at Ridgetown, 2012-2013

N Rate (lbs/ac)	Hybrid											
	A		B		C		D		E		F	
Grain Yield (bu/ac @ 15.5% Moisture)												
2012												
0	135.7	b	150.7	c	145.7	c	133.0	c	123.6	c	145.5	b
120	185.9	a	213.6	b	211.8	ab	199.6	b	218.9	b	221.1	a
180	193.8	a	221.9	ab	208.1	b	200.1	b	234.9	a	229.0	a
240	196.8	a	227.1	a	223.2	a	216.7	a	245.5	a	234.4	a
2013												
0	155.4	b	172.6	b	167.5	b	159.3	b	172.8	b	171.0	b
120	188.3	a	205.8	a	207.2	a	216.1	a	226.8	a	221.6	a
180	190.5	a	208.8	a	212.4	a	225.2	a	234.5	a	226.1	a
240	188.9	a	208.8	a	212.5	a	223.1	a	231.6	a	229.2	a

Means with the same letter within hybrid and year are not different (p=0.05).

Hybrid x Nitrogen Rate Interaction 2012/13

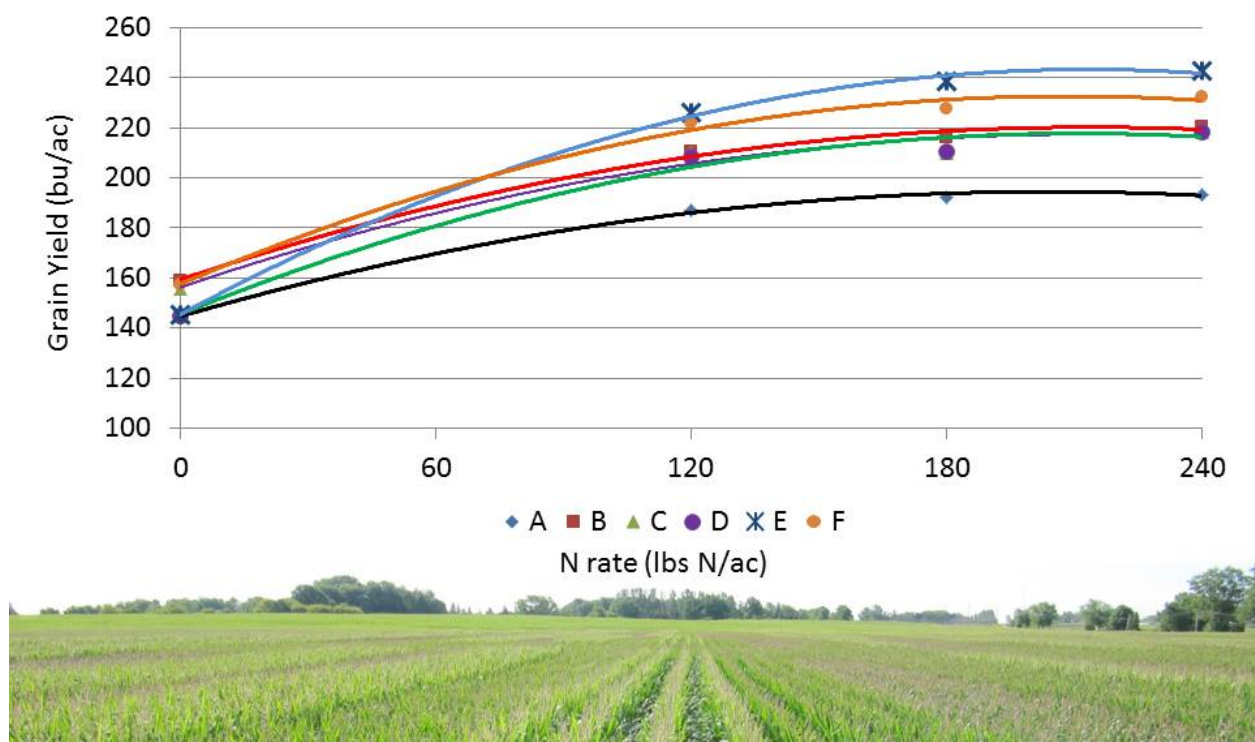


Figure 1. Nitrogen response curves for six hybrids (A-F), averaged across population, fungicide treatment, and year at Ridgetown 2012-2013.

Preliminary Omission Analysis 2-Year

CHANGE FROM NORMAL	Hybrid Ave	H1	H2	H3	H4	H5	H6
POPULATION	+10	+9	+4	+7	+5	+26	+10
NITROGEN	+11	+4	+6	+10	+15	+21	+6
FUNGICIDE	+3	0	+5	+1	0	+13	0
POP + N + F	+22	+19	+19	+20	+22	+40	+22
POP+N	+19	+13	+15	+14	+16	+34	+22
POP+F	+11	+10	+2	+4	+7	+27	+12
N+F	+12	+8	+11	+2	0	+36	+15

Normal Practice: 32K ppa + 120 lbs N/ac + no fungicide

Change: POP=44K ppa; N=240 lbs/ac; Fungicide= Quilt or Acapela @ VT

Figure 2. Hybrid differences with increases in population, nitrogen, and fungicide alone, and combinations (POP+N, POP+F, N+F, POP+N+F), pooled across Ridgetown locations during 2012 and 2013.

Stress Tolerance: Hybrid B > Hybrid A?



Figure 3. Visual differences of Hybrid A and Hybrid B at R1 under drought stress at Ridgeway, Ontario, Canada, in 2012.

Table 5a. Moisture content at harvest as affected by N rates, fungicide, and population at Ridgetown, 2012.

Hybrid	N Rate (lbs/ac)	32,000 ppa				42,000 ppa			
		UTC		Fungicide		UTC		Fungicide	
Harvest Moisture (%)									
"Hybrid A"	0	19.6	cd	19.8	cd	19.4	d	19.7	cd
	120	20.1	bcd	20.5	abcd	20.6	abc	20.3	abcd
	180	20.6	abc	20.7	abc	21.4	a	20.6	abc
	240	20.6	abc	19.8	cd	20.7	abc	21.0	ab
"Hybrid B"	0	20.1	e	20.0	e	20.5	cde	20.5	cde
	120	20.3	de	20.9	bcde	21.0	bcde	21.5	abc
	180	20.6	cde	21.9	ab	21.6	abc	21.7	abc
	240	21.4	bcd	21.4	bcd	21.5	bcd	22.7	a
"Hybrid C"	0	16.5	d	16.5	d	16.6	cd	17.1	abcd
	120	17.8	ab	17.6	abcd	17.3	abcd	17.8	abc
	180	16.9	bcd	17.2	abcd	17.5	abcd	18.2	a
	240	17.8	ab	18.0	ab	17.1	abcd	18.1	ab
"Hybrid D"	0	18.3	abcde	18.0	bcde	17.4	e	17.7	de
	120	18.3	abcde	18.8	abc	17.9	cde	18.5	abcde
	180	19.1	ab	18.8	abcd	19.4	a	18.6	abcde
	240	18.9	abc	19.4	a	18.8	abcd	19.2	a
"Hybrid E"	0	17.8	ab	17.7	ab	17.3	b	17.6	ab
	120	18.2	ab	17.7	ab	18.1	ab	17.9	ab
	180	18.4	ab	18.4	ab	17.7	ab	18.5	ab
	240	17.9	ab	18.2	ab	18.6	a	17.9	ab
"Hybrid F"	0	18.0	bc	17.8	c	18.3	bc	18.1	bc
	120	17.9	c	17.8	c	19.1	ab	18.6	abc
	180	18.7	abc	18.7	abc	19.2	ab	19.6	a
	240	18.5	abc	17.8	c	17.7	c	19.6	a

Means with the same letter within hybrid are not different (p=0.05).

Table 5b. Moisture content at harvest as affected by N rates, fungicide, and population at Ridgetown, 2013.

Hybrid	N Rate (lbs/ac)	32,000 ppa				42,000 ppa			
		UTC		Fungicide		UTC		Fungicide	
Harvest Moisture (%)									
“Hybrid A”	0	17.7	a	17.7	a	17.5	a	17.5	a
	120	17.7	a	17.9	a	17.5	a	17.3	a
	180	17.8	a	17.9	a	17.7	a	17.6	a
	240	17.9	a	17.8	a	17.6	a	17.5	a
“Hybrid B”	0	17.5	a	17.5	a	17.4	a	17.7	a
	120	17.4	a	17.3	a	17.6	a	17.4	a
	180	17.5	a	17.8	a	17.7	a	17.9	a
	240	17.2	a	17.4	a	17.5	a	17.4	a
“Hybrid C”	0	21.7	a	21.2	abcd	19.9	ef	20.2	bcdef
	120	21.3	ab	19.5	f	20.3	bcdef	20.0	cdef
	180	21.2	abc	21.4	ab	20.6	abcdef	21.0	abcde
	240	20.0	cdef	19.7	ef	20.0	cdef	19.8	def
“Hybrid D”	0	21.0	ab	20.9	ab	21.2	ab	20.2	b
	120	21.8	a	21.4	ab	21.0	ab	21.0	ab
	180	20.2	b	21.2	ab	20.1	b	20.9	ab
	240	21.7	a	21.3	ab	21.0	ab	21.0	ab
“Hybrid E”	0	21.6	abcdef	22.0	abcd	21.4	abcdefg	21.7	abcde
	120	22.2	ac	20.5	efgh	20.9	bdefgh	20.8	defgh
	180	20.9	cdefgh	21.4	abcdefg	21.4	abcdefg	22.2	ab
	240	20.8	defgh	20.3	fgh	19.9	h	20.1	gh
“Hybrid F”	0	21.9	bc	22.4	abc	22.3	abc	21.9	abc
	120	23.0	ab	23.3	a	22.2	abc	22.0	abc
	180	21.4	c	22.4	abc	22.2	abc	22.4	abc
	240	22.6	abc	21.9	bc	21.8	bc	21.6	c

Means with the same letter within hybrid are not different ($p=0.05$).

Table 6a. SPAD readings at developmental stage R4 by as affected by N rates, fungicide, and population at Ridgetown, 2012.

Hybrid	N Rate (lbs/ac)	32,000 ppa				42,000 ppa			
		UTC		Fungicide		UTC		Fungicide	
"Hybrid A"	0	30.9	f	36.5	e	30.0	f	36.6	e
	120	53.2	bcd	53.1	abcd	49.8	d	51.1	cd
	240	58.4	a	57.4	ab	54.8	abcd	55.7	abc
"Hybrid B"	0	30.8	de	31.7	d	25.8	e	26.1	de
	120	48.8	bc	51.6	abc	47.9	bc	46.4	c
	240	56.3	a	56.5	a	53.1	ab	54.6	a
"Hybrid C"	0	32.8	de	32.3	de	29.4	e	35.2	d
	120	52.4	abc	55.7	ab	50.6	bc	48.6	c
	240	57.1	a	57.4	a	55.0	ab	55.2	ab
"Hybrid D"	0	25.1	c	33.7	b	27.0	c	24.9	c
	120	50.1	a	51.9	a	50.0	a	50.0	a
	240	55.3	a	54.4	a	53.0	a	50.9	a
"Hybrid E"	0	29.5	b	33.2	b	29.0	b	29.2	b
	120	49.9	a	51.9	a	50.0	a	49.3	a
	240	54.4	a	52.6	a	52.7	a	53.0	a
"Hybrid F"	0	35.9	c	35.0	c	33.9	c	31.2	c
	120	53.6	ab	53.8	ab	51.5	b	52.9	ab
	240	57.2	a	56.3	ab	54.7	ab	54.5	ab

Means with the same letter within hybrid are not different ($p=0.05$).

Table 6b. SPAD readings at developmental stage R4 by as affected by N rates, fungicide, and population at Ridgetown, 2013.

Hybrid	N Rate (lbs/ac)	32,000 ppa				42,000 ppa			
		UTC		Fungicide		UTC		Fungicide	
"Hybrid A"	0	50.4	abc	48.3	bc	48.1	c	51.4	abc
	120	55.5	a	53.7	abc	56.0	a	56.6	a
	240	53.3	abc	51.4	abc	55.4	ab	53.9	abc
"Hybrid B"	0	43.9	c	47.0	bc	46.6	bc	45.6	c
	120	55.5	a	55.1	a	55.0	a	54.9	a
	240	55.2	a	53.6	ab	57.0	a	55.3	a
"Hybrid C"	0	44.8	c	48.7	bc	47.8	bc	43.2	c
	120	54.4	ab	55.6	a	53.2	ab	53.1	ab
	240	54.4	ab	53.9	ab	53.8	ab	54.2	ab
"Hybrid D"	0	42.9	b	40.5	b	44.3	b	42.7	b
	120	51.4	a	54.6	a	55.0	a	51.6	a
	240	54.5	a	52.3	a	53.5	a	52.5	a
"Hybrid E"	0	45.4	cd	46.1	bcd	48.1	abcd	42.0	d
	120	54.1	a	54.5	a	53.7	a	50.4	abc
	240	54.4	a	53.6	a	52.7	ab	51.1	abc
"Hybrid F"	0	48.0	bcde	44.3	e	47.2	cde	44.9	de
	120	54.6	ab	54.6	ab	53.7	abc	51.4	abcd
	240	52.9	abc	52.9	abc	55.1	a	53.6	abc

Means with the same letter within hybrid are not different ($p=0.05$).

Table 7a. Stalk lodging at harvest by hybrid as affected by N rates, fungicide, and population at Ridgetown, 2012.

Hybrid	N Rate (lbs/ac)	32,000 ppa		42,000 ppa	
		UTC	Fungicide	UTC	Fungicide
				%	
"Hybrid C"	0	4 bc	2 c	20 a	10 abc
	120	3 c	2 c	14 ab	4 bc
	180	3 bc	2 c	10 abc	7 bc
	240	4 bc	2 c	14 ab	10 abc
"Hybrid D"	0	20 bc	12 cdef	29 ab	37 a
	120	8 defg	5 efg	20 bc	19 c
	180	4 fg	2 fg	11 cdefg	14 cde
	240	2 fg	2 g	11 cdefg	16 cd
"Hybrid E"	0	5 cdefg	3 defg	10 abcdefg	13 abcd
	120	7 bcdefg	1 g	12 abcdef	15 abc
	180	7 bcdefg	3 efg	19 a	13 abcde
	240	3 efg	2 fg	19 a	17 ab
"Hybrid F"	0	11 fgh	7 h	22 cdef	35 b
	120	17 efgh	11 gh	18 defg	16 efgh
	180	25 bcde	13 fgh	32 bc	51 a
	240	28 bcd	19 defg	55 a	53 a

Means with same letter within hybrid are not different ($p=0.05$). Lodging notes for "Hybrids A and B" are not presented; data on those hybrids were recorded approximately 3 weeks before other hybrids with later maturities, with lodging near zero.

Table 7b. Stalk lodging at harvest by hybrid as affected by N rates, fungicide, and population at Ridgetown, 2013.

Hybrid	N Rate (lbs/ac)	32,000 ppa				42,000 ppa						
		UTC		Fungicide		UTC		Fungicide				
Lodging (%)												
“Hybrid A”	0	2	a		3.3	a		0.5	a		2.3	a
	120	0	a		0	a		0	a		0.5	a
	180	0.5	a		1	a		0.3	a		0.3	a
	240	0	a		0	a		0.3	a		0	a
“Hybrid B”	0	2	a		2.3	a		1.8	a		0.8	a
	120	0.8	a		0	a		0.8	a		2.5	a
	180	0.5	a		0.3	a		0.5	a		0.5	a
	240	0	a		0.8	a		0.8	a		0.8	a
“Hybrid C”	0	5	abc		9	a		1.8	cde		6.8	ab
	120	0.5	cde		4	bcde		1.3	cde		2.8	bcde
	180	0.5	cde		3.5	bcde		0.5	cde		2.3	bcde
	240	0.3	de		2.8	bcde		0	e		4.8	abcd
“Hybrid D”	0	3.5	bc		14	a		2.5	bc		15.8	a
	120	0.8	bc		3.8	bc		0	c		2.5	bc
	180	0.8	bc		2	bc		0	c		2.8	bc
	240	0.5	bc		3	bc		0.5	bc		4.8	b
“Hybrid E”	0	0.8	b		2.3	b		0	b		7.3	a
	120	0.3	b		0.8	b		0	b		1.8	b
	180	0.3	b		0.5	b		0.3	b		1.3	b
	240	0.3	b		0	b		0.5	b		0.5	b
“Hybrid F”	0	6.5	bc		15.3	a		2.8	cdef		16	a
	120	1.8	def		5.8	bcde		1.3	ef		5.8	bcde
	180	3.5	cdef		5.3	bcde		0.3	f		9.3	b
	240	1.8	def		6.3	bcd		0.3	f		6	bcd

Means followed by the same letter within hybrid are not different (p=0.05).

Table 8a. Grain oil content as affected by N rates, fungicide, and population at Ridgetown, 2012.

Hybrid	N Rate (lbs/ac)	32,000 ppa				42,000 ppa			
		UTC		Fungicide		UTC		Fungicide	
Grain Oil Content (%)									
“Hybrid A”	0	3.8	a	3.9	a	3.9	a	3.9	a
	120	3.8	a	3.7	a	3.9	a	3.8	a
	180	3.8	a	3.9	a	3.9	a	3.9	a
	240	3.8	a	3.9	a	3.8	a	3.8	a
“Hybrid B”	0	3.9	a	3.9	a	3.8	a	3.9	a
	120	3.9	a	3.8	a	3.8	a	3.8	a
	180	3.9	a	3.8	a	3.9	a	3.9	a
	240	3.8	a	3.9	a	3.8	a	3.8	a
“Hybrid C”	0	4.1	de	4.4	ab	4.1	e	4.5	ab
	120	4.2	cde	4.6	a	4.1	e	4.3	bc
	180	4.4	ab	4.5	ab	4.3	bc	4.4	ab
	240	4.3	bcd	4.4	ab	4.3	bcd	4.4	ab
“Hybrid D”	0	3.5	cd	3.6	bcd	3.6	abcd	3.8	a
	120	3.5	d	3.8	a	3.5	cd	3.8	ab
	180	3.7	abc	3.8	ab	3.7	abcd	3.8	ab
	240	3.7	abc	3.8	ab	3.7	abc	3.7	ab
“Hybrid E”	0	3.9	ef	4.1	abcd	3.8	f	4.0	abcde
	120	4.0	bcdef	4.1	abcde	4.0	cdef	4.1	abc
	180	4.1	abcde	4.1	abcde	4.1	abcde	4.2	a
	240	4.0	abcde	4.2	ab	3.9	def	4.0	bcdef
“Hybrid F”	0	3.7	c	4.0	ab	3.9	abc	3.9	abc
	120	3.9	abc	4.0	ab	3.8	bc	4.0	ab
	180	4.0	ab	4.0	a	4.0	ab	4.0	ab
	240	3.9	abc	3.9	abc	3.9	abc	3.9	abc

Means followed by the same letter within hybrid are not different ($p=0.05$).

Table 8b. Grain oil content as affected by N rates, fungicide, and population at Ridgetown, 2013.

Hybrid	N Rate (lbs/ac)	32,000 ppa				42,000 ppa			
		UTC		Fungicide		UTC		Fungicide	
Grain Oil Content (%)									
“Hybrid A”	0	3.7	abc	3.7	bc	3.8	abc	3.7	bc
	120	3.8	ab	3.7	bc	3.9	a	3.7	bc
	180	3.7	bc	3.6	c	3.7	bc	3.7	bc
	240	3.7	bc	3.6	c	3.7	bc	3.6	c
“Hybrid B”	0	3.9	ab	3.7	def	3.8	bcd	3.6	ef
	120	3.9	abc	3.7	cde	4.0	a	3.7	def
	180	3.7	cde	3.8	cd	3.7	def	3.6	f
	240	4.0	a	3.7	def	3.8	bcd	3.7	cde
“Hybrid C”	0	4.0	bcde	4.1	abc	3.9	cdefg	4.2	a
	120	3.9	cdefg	3.9	defg	3.9	cdefg	3.8	fg
	180	3.9	cdefg	4.0	abcd	4.1	ab	4.0	bcdef
	240	4.0	cdefg	3.9	defg	3.8	g	3.9	efg
“Hybrid D”	0	3.8	a	3.7	abc	3.7	abc	3.7	abc
	120	3.8	ab	3.7	bc	3.6	c	3.6	c
	180	3.7	abc	3.7	abc	3.7	abc	3.6	bc
	240	3.7	bc	3.7	bc	3.7	bc	3.6	c
“Hybrid E”	0	4.1	bc	4.0	cde	4.3	a	3.9	def
	120	4.2	ab	3.9	defg	4.1	abc	3.8	defg
	180	4.1	bc	3.9	def	4.0	bcd	3.9	def
	240	3.9	defg	3.8	fg	3.7	g	3.8	efg
“Hybrid F”	0	3.7	a	3.7	a	3.7	a	3.7	a
	120	3.7	a	3.7	a	3.7	a	3.7	a
	180	3.7	a	3.8	a	3.7	a	3.7	a
	240	3.7	a	3.7	a	3.7	a	3.7	a

Means followed by the same letter within hybrid are not different (p=0.05).

Table 9a. Grain protein content as affected by N rates, fungicide, and population at Ridgetown, 2012.

Hybrid	N Rate (lbs/ac)	32,000 ppa				42,000 ppa			
		UTC		Fungicide		UTC		Fungicide	
Grain Protein Content (%)									
“Hybrid A”	0	7.7	d	7.3	d	7.9	d	7.6	d
	120	9.7	abc	9.4	bc	10.3	abc	9.4	c
	180	10.5	abc	10.0	abc	10.6	ab	10.0	abc
	240	10.5	abc	9.9	abc	10.8	a	10.3	abc
“Hybrid B”	0	7.6	e	7.5	e	8.1	de	7.6	e
	120	9.2	bcd	9.3	bc	9.5	abc	8.9	cd
	180	9.9	abc	9.8	abc	10.4	ab	9.5	abc
	240	10.0	abc	9.9	abc	10.6	a	9.9	abc
“Hybrid C”	0	7.8	e	7.7	e	8.0	e	7.7	e
	120	9.6	abcd	8.8	bcde	8.6	cde	8.8	bcde
	180	9.9	ab	8.4	de	10.2	a	9.5	abcd
	240	10.0	a	9.8	abc	10.5	a	9.6	abcd
“Hybrid D”	0	8.0	ef	8.0	ef	9.0	bcdef	7.8	f
	120	9.9	ab	9.2	bcd	8.6	cdef	9.1	bcde
	180	10.0	ab	8.4	def	10.4	a	10.0	ab
	240	10.1	ab	9.8	abc	10.5	a	10.0	ab
“Hybrid E”	0	8.5	cd	8.2	d	8.7	abcd	8.3	d
	120	9.3	abcd	9.2	abcd	8.2	d	8.6	bcd
	180	9.7	abc	8.3	d	9.6	abc	9.2	abcd
	240	9.7	ab	9.4	abcd	9.9	a	9.6	abc
“Hybrid F”	0	8.0	def	7.6	f	8.0	def	7.9	ef
	120	9.3	abc	8.4	bcdef	8.1	def	8.9	abcde
	180	9.1	abcd	8.1	cdef	9.5	ab	9.5	ab
	240	9.4	abc	9.4	ab	9.7	a	9.5	ab

Means followed by the same letter within hybrid are not different (p=0.05).

Table 9b. Grain protein content as affected by N rates, fungicide, and population at Ridgetown, 2013.

Hybrid	N Rate (lbs/ac)	32,000 ppa				42,000 ppa			
		UTC		Fungicide		UTC		Fungicide	
Grain Protein Content (%)									
“Hybrid A”	0	7.8	g	7.4	g	7.6	g	7.7	g
	120	9.3	bcd	8.4	f	9.5	abc	8.6	ef
	180	9.6	ab	8.8	def	10.0	a	8.9	def
	240	10.0	a	8.9	def	10.1	a	9.0	cde
“Hybrid B”	0	7.2	e	7.4	de	7.4	de	7.7	d
	120	8.7	bc	8.7	c	8.7	bc	8.8	bc
	180	9.1	abc	9.0	abc	9.2	ab	9.0	abc
	240	8.9	abc	9.1	abc	9.3	a	9.0	abc
“Hybrid C”	0	7.2	f	6.8	f	7.2	f	6.9	f
	120	8.4	abcd	7.8	e	8.1	cde	7.9	de
	180	8.7	ab	8.2	bcde	8.6	abc	8.3	abcde
	240	8.7	ab	8.3	abcde	8.8	a	8.4	abcd
“Hybrid D”	0	7.7	f	7.5	f	7.6	f	7.8	f
	120	9.2	bcde	9.0	de	9.0	cde	8.8	e
	180	9.5	abc	9.5	abcd	9.7	ab	9.5	abcd
	240	9.6	ab	9.6	abc	9.9	a	9.4	abcd
“Hybrid E”	0	7.6	de	7.3	de	7.7	cd	7.2	e
	120	8.5	ab	8.2	bc	8.6	ab	8.2	bc
	180	8.5	ab	8.5	ab	8.7	ab	8.5	ab
	240	8.7	ab	8.6	ab	8.8	a	8.6	ab
“Hybrid F”	0	7.3	c	7.1	c	7.1	c	6.9	c
	120	8.2	ab	7.9	b	8.2	ab	7.9	b
	180	8.4	ab	8.4	ab	8.5	a	8.3	ab
	240	8.6	a	8.5	a	8.5	a	8.4	ab

Means followed by the same letter within hybrid are not different (p=0.05).

Table 10a. Grain starch content as affected by N rates, fungicide, and population at Ridgetown, 2012.

Hybrid	N Rate (lbs/ac)	32,000 ppa				42,000 ppa			
		UTC		Fungicide		UTC		Fungicide	
Grain Starch Content (%)									
“Hybrid A”	0	73.8	a	74.3	a	73.6	a	73.7	a
	120	72.3	bc	72.5	b	71.8	bcde	72.3	bcd
	180	71.7	cde	72.4	bcd	71.7	cde	72.2	bcde
	240	71.6	de	72.2	bcde	71.5	e	71.9	bcde
“Hybrid B”	0	73.3	ab	73.6	a	72.7	bc	73.2	ab
	120	72.1	cdefg	72.4	cde	71.6	fgh	72.5	cd
	180	71.6	efgh	71.8	defg	71.1	h	72.2	cdef
	240	71.5	gh	71.9	defg	71.6	efgh	71.5	fgh
“Hybrid C”	0	72.8	a	72.6	a	72.6	a	72.9	a
	120	71.2	bc	71.7	b	71.3	bc	71.5	bc
	180	70.8	cd	71.2	bc	70.8	cd	71.1	bcd
	240	70.9	cd	71.0	bcd	70.4	d	71.2	bc
“Hybrid D”	0	73.4	ab	73.6	a	72.7	bc	73.3	ab
	120	71.9	def	72.4	cde	71.7	ef	72.5	cd
	180	71.9	def	71.9	def	71.6	f	71.8	ef
	240	71.6	f	72.1	cdef	71.5	f	72.1	cdef
“Hybrid E”	0	72.4	ab	72.5	a	72.1	abc	72.1	abcd
	120	71.5	cde	71.7	bcde	71.4	de	72.1	abcd
	180	71.5	cde	71.6	cde	71.0	ef	71.6	bcde
	240	70.7	f	71.6	cde	71.1	ef	71.1	ef
“Hybrid F”	0	73.0	abcd	73.7	a	73.2	ab	73.1	abc
	120	71.9	fg	72.7	bcde	72.2	efg	72.4	cdef
	180	72.4	cdef	72.3	defg	71.7	fg	72.2	efg
	240	72.0	efg	72.2	efg	71.6	g	72.2	efg

Means followed by the same letter within hybrid are not different (p=0.05).

Table 10b. Grain starch content as affected by N rates, fungicide, and population at Ridgetown, 2013.

Hybrid	N Rate (lbs/ac)	32,000 ppa				42,000 ppa			
		UTC		Fungicide		UTC		Fungicide	
Grain Starch Content (%)									
“Hybrid A”	0	74.2	bc	74.9	a	74.5	ab	74.5	ab
	120	73.1	fg	74.2	bc	73.3	efg	73.8	cde
	180	73.3	efg	74.1	bcd	72.8	g	73.7	cde
	240	72.8	g	74.0	bcd	72.8	g	73.5	def
“Hybrid B”	0	74.4	a	74.4	a	74.1	ab	74.0	abc
	120	73.6	bcde	73.7	bcde	73.7	bcde	73.3	e
	180	73.3	de	73.9	abcd	73.2	e	73.9	abcd
	240	73.8	bcde	73.8	bcde	73.4	cde	73.6	bcde
“Hybrid C”	0	73.7	bc	74.6	a	73.7	bcd	73.9	ab
	120	72.5	gh	73.9	b	73.1	defg	73.0	efgh
	180	72.4	h	73.2	cdef	72.7	fgh	73.6	bcde
	240	72.6	fgh	73.4	bcde	72.5	gh	73.3	bcde
“Hybrid D”	0	73.9	abc	74.5	a	73.6	bcde	74.1	ab
	120	73.1	def	73.6	bcde	73.3	cdef	73.7	bcd
	180	73.1	ef	73.6	bcde	72.7	fg	73.1	def
	240	73.0	efg	73.3	cdef	72.4	g	73.4	cde
“Hybrid E”	0	72.7	def	73.5	ab	72.9	cdef	73.3	abcd
	120	73.0	bcde	73.7	a	72.6	ef	73.6	ab
	180	73.0	bcde	73.5	abc	72.6	ef	73.3	abcd
	240	72.4	f	73.4	abc	72.6	ef	73.3	abcd
“Hybrid F”	0	74.1	abcd	74.3	abc	74.4	ab	74.6	a
	120	73.7	cdef	74.3	abc	73.4	efg	74.1	abcde
	180	73.5	efg	73.4	efg	73.1	g	73.8	bcdef
	240	73.5	defg	73.8	bcdef	73.1	g	73.4	fg

Means followed by the same letter within hybrid are not different (p=0.05).