2013

Brown Mid-Rib Corn Variety Trial

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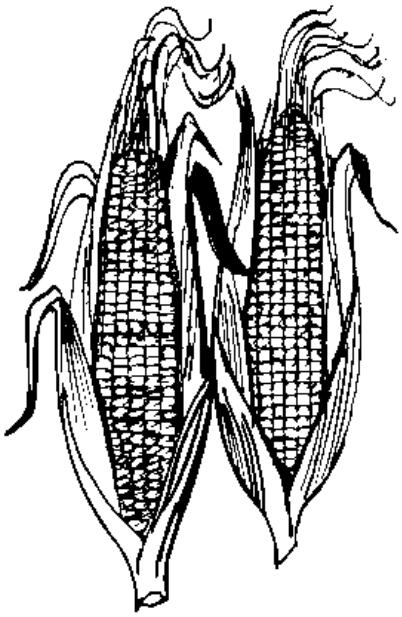

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The UNIVERSITY of VERMONT EXTENSION

2012 Vermont Brown Mid-Rib Corn Variety Trial

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Brown mid-rib (BMR) corn has a lower lignin content than other silage corn varieties. The lower lignin content increases the fiber digestibility (NDF digestibility) of the corn silage. Increases in NDF digestibility lead to increased in dry matter intake, milk production, milk protein content, and better body condition. Several studies have reported that for every one percentage point increase in NDF digestibility fed to dairy cattle there will be a 0.50 lb per day increase in milk production. Feeding BMR corn silage is a means to increase NDF digestibility and milk production. Since 2010, the University of Vermont Extension Northwest Crops & Soils program has conducted research trials to evaluate BMR corn silage varieties. In 2012, the trial included 10 varieties from three different seed companies. While the information presented can begin to describe the yield and quality performance of these BMR corn varieties in this region, it is important to note that the data represent results from only one season and one location. Compare other hybrid performance data before making varietal selections.

MATERIALS AND METHODS

A trial was conducted at Borderview Farm in Alburgh, Vermont in 2012 in order to evaluate yield and quality of ten BMR corn varieties (Table 1). The soil was a Benson rocky silt loam, and the area was previously planted to silage corn. The experimental design was a randomized block of 5'x50' plots with four replications. The seedbed was prepared with spring disking and harrowing and finished with a spike-toothed harrow. The corn was planted on 18-May at a rate of 34,000 seeds per acre with a John Deere 1750 four-row corn planter.

Table 1. Agronomic information for the 2012 BMR corn variety trial at Borderview Farm.

Location	Borderview Farm – Alburgh, VT
Soil type	Rocky Benson silt loam
Previous crop	Silage corn
Tillage operations	Spring disk, harrow, spike-toothed harrow
Plot size (ft.)	5 x 50
Replicates	4
Seeding rate	34,000 seeds ac^{-1}
Row width (in.)	30
Planting date	18-May
Starter fertilizer	200 lbs ac^{-1} of 10-20-20
Additional fertilizer	92 lbs N ac^{-1} of urea (46-0-0) at V-6 stage, 23-Jun
Herbicide	Lumax®, 3 pt ac^{-1}; 31-May
Harvest dates	14-Sept and 25-Sept

Treatments were 10 BMR corn hybrids (Table 2). The seed for this trial was donated by three participating seed companies, Mycogen, Pioneer, and Seedway, LLC, whose contact information is listed below. Varieties ranged from 88-113 days in relative maturity (RM). Relative maturity and seed trait information was provided by the seed companies.

Mycogen	Pioneer	Seedway
Claude Fortin District Sales Manager Highgate, Vermont (802) 363-2803	Jacob Bourdeau Bourdeau Bros. Sheldon, VT (802) 933-2277	Ed Schillawski 3442 Rte. 22A Shoreham, Vermont (802) 897-2281

Table 2. Relative maturities and listed traits of ten BMR varieties.

Variety	Company	Relative Maturity (RM)	Traits
F2F298	Mycogen	88-90	BMR, HXI, LL, RR2
F2F343	Mycogen	92	BMR, RR2
3737BMR	Seedway	94	BMR
F2F387	Mycogen	95	BMR, HXT, LL, RR2
F2F488	Mycogen	98	BMR, HXT, LL, RR2
5555BMR	Seedway	104	BMR
F2F569	Mycogen	104	BMR, HXT, LL, RR2
F2F626	Mycogen	108	SmartStax
F2F665	Mycogen	109	BMR, HXT, LL, RR2
P1376XR	Pioneer	113	BMR, HXX, LL, RR2

BMR = Brown mid-rib, a naturally-occurring gene
HXI = Herculex® I Insect Protection, glyphosate (Roundup®, Touchdown®) and glufosinate (Ignite®) herbicide tolerance
HXT = Herculex Xtra®, provides season-long control of a variety of pests, including European corn borer, western bean cutworm, corn rootworm
HXX = Herculex XTRA® (HXX) combines Herculex I and Herculex RW traits to provide consistent, season-long control of corn rootworms, allows protection in-plant and above-and below-ground
LL = Glufosinate-ammonium (LibertyLink®) herbicide tolerance
RR2 = Roundup Ready corn, glyphosate (Roundup®, Touchdown®) herbicide tolerance
SmartStax = Genuity® SmartStax™, provides control of a variety of pests, including European corn borer, western bean cutworm, corn rootworm, provides herbicide flexibility and makes possible a 5% refuge requirement

The corn trial was planted on the 18-May at a rate of 34,000 seeds per acre. A 10-20-20 starter fertilizer was applied at 200 lbs per acre at the time of planting. On 31-May, Syngenta's selective herbicide Lumax® (S-Metolachlor, atrazine, and mesotrione) was applied at a rate of 3 pints per acre. The corn was topdressed with 46-0-0 (urea) at 200 lbs per acre, or 92 lbs of actual N per acre on 23-June. Plots were harvested on 14-Sept and 25-Sept, depending on maturity and moisture levels. Harvesting was performed with a John Deere two-row chopper, and whole-plant silage was collected and weighed in a forage wagon. Chopped silage was then dried and ground with a Wiley laboratory mill. A subsample was retained for forage quality analysis.

Silage quality was analyzed using wet chemistry at Cumberland Valley Analytical Services in Hagerstown, MD. Plot samples were analyzed for crude protein (CP), starch, acid detergent fiber (ADF), and neutral detergent fiber (NDF). Mixtures of true proteins, composed of amino acids, and nonprotein nitrogen make up the CP content of forages. The CP content of forages is determined by measuring the amount of nitrogen and multiplying by 6.25. The bulky characteristics of forage come from fiber. Forage feeding values are negatively associated with fiber since the less digestible portions of plants are contained in the fiber fraction. The detergent fiber analysis system separates forages into two parts: cell

contents, which include sugars, starches, proteins, nonprotein nitrogen, fats and other highly digestible compounds; and the less digestible components found in the fiber fraction. The total fiber content of forage is contained in the neutral detergent fiber (NDF). Chemically, this fraction includes cellulose, hemicellulose, and lignin. Because of these chemical components and their association with the bulkiness of feeds, NDF is closely related to feed intake and rumen fill in cows. Recently, forage testing laboratories have begun to evaluate forages for NDF digestibility (dNDF). Evaluation of forages and other feedstuffs for dNDF is being conducted to aid prediction of feed energy content and animal performance. Research has demonstrated that lactating dairy cows will eat more dry matter and produce more milk when fed forages with optimum dNDF. Forages with increased dNDF will result in higher energy values, and perhaps more importantly, increased forage intakes. Forage dNDF can range from 20–80%, and is typically higher in BMR corn than conventional silage corn.

Net energy for lactation (NE_L) is calculated based on concentrations of NDF and ADF. NE_L can be used as a tool to determine the quality of a ration, but should not be considered the sole indicator of the quality of a feed, as NE_L is affected by the quantity of a cow's dry matter intake, the speed at which her ration is consumed, the contents of the ration, feeding practices, the level of her production, and many other factors. Most labs calculate NE_L at an intake of three times maintenance. Starch can also have an effect on NE_L, where the greater the starch content, the higher the NE_L (measured in Mcal per pound of silage), up to a certain point. High grain corn silage can have average starch values exceeding 40%, although levels greater than 30% are not considered to affect energy content, and might in fact have a negative impact on digestion. Starch levels vary from field to field, depending on growing conditions and variety.

Non-fiber carbohydrate (NFC) and nonstructural carbohydrate (NSC) are also totaled and reported. NFC is comprised of starch, simple sugars, and soluble fiber, and is digested more quickly and efficiently than fiber. NFC provides energy for rumen microbes, once it is fermented by volatile fatty acids. NFC and NSC are sometimes referred to almost interchangeably, but pectin levels are included in NFC and omitted from NSC. In addition, NFC is calculated by difference [100 – (% NDF + % crude protein + % fat + % ash)], whereas NSC is determined through enzymatic methods. NSC should be in the 30-40% range, on a dry matter basis. NFC is generally between 35-40% in a high milk production ration, though levels as high as 42% are acceptable, due to the variability of particle size, frequency of feeding, dry matter intake, and other factors.

The silage performance indices of milk per acre and milk per ton were calculated using a model derived from the spreadsheet entitled, "MILK2000" developed by researchers at the University of Wisconsin. Milk per ton measures the pounds of milk that could be produced from a ton of silage, on a dry matter basis. This value is generated by approximating a balanced ration meeting animal energy, protein, and fiber needs based on silage quality. The value is based on a standard cow weight and level of milk production. Milk per acre is calculated by multiplying the milk per ton value by silage dry matter yield. Therefore milk per ton is an overall indicator of forage quality and milk per acre an indicator of forage yield and quality. Milk per ton and milk per acre calculations provide relative rankings of forage samples, but should not be considered as predictive of actual milk responses in specific situations for the following reasons:

1) Equations and calculations are simplified to reduce inputs for ease of use,
2) Farm-to-farm differences exist,

3) Genetic, dietary, and environmental differences affecting feed utilization are not considered.

Variations in yield and quality can occur because of variations in genetics, soil, weather, and other growing conditions. Statistical analysis makes it possible to determine whether a difference among treatments is real or whether it might have occurred due to other variations in the field. All data was analyzed using a mixed model analysis where replicates were considered random effects. At the bottom of each table a LSD value is presented for each variable (e.g. yield). Least Significant Differences (LSD's) at the 10% level (0.10) of probability are shown. Where the difference between two treatments within a column is equal to or greater than the LSD value at the bottom of the column, you can be sure in 9 out of 10 chances that there is a real difference between the two values. Treatments that were not significantly lower in performance than the highest value in a particular column are indicated with an asterisk.

In the example below, hybrid A is significantly different from hybrid C but not from hybrid B. The difference between A and B is equal to 1.5, which is less than the LSD value of 2.0. This means that these two hybrids did not differ in yield. The difference between A and C is equal to 3.0, which is greater than the LSD value of 2.0. This means that the yields of these two hybrids were significantly different from one another.

Hybrid	Yield
A	**9.0***
B	7.5*
C	6.0
LSD (0.10)	2.0

RESULTS

Using data from a Davis Instruments Vantage Pro2 weather station at Borderview Farm in Alburgh, VT, weather data was summarized for the 2012 growing season (Table 3). Though May was warmer and wetter than normal (based on 1981-2010 data), June, July, and August all had less precipitation than average. There were an accumulated 2,545 Growing Degree Days (GDDs) at a base temperature of 50°F. This was 264 more than the historical 30-year average for May-September.

Table 3. Summarized weather data for 2012 – Alburgh, VT.

Alburgh, VT	May	June	July	August	September
Average temperature (°F)	60.5	67.0	71.4	71.1	60.8
Departure from normal	4.1	1.2	0.8	2.3	0.2
Precipitation (inches)*	3.9	3.2	3.8	2.9	5.4
Departure from normal	0.5	-0.5	-0.4	-1.0	1.7
Growing Degree Days (base 50°F)	370	504	657	650	364
Departure from normal	102	30	17	69	46

Based on weather data from an on-site Davis Instruments Vantage Pro2 weather station with a Weatherlink data logger. Historical averages are for 30 years of NOAA data from Burlington, VT (1981-2010).

* Precipitation data from June-September is based on Northeast Regional Climate Center data from an observation station in Burlington, VT.

Yields were adjusted to 35% dry matter and were statistically different by variety. The highest yielding varieties were Pioneer variety 'P1376XR,' Mycogen's 'F2F665,' 'F2F626,' 'F2F488,' 'F2F569,' and 'F2F343' (Figure 1). The overall trial average yield was 19.8 tons per acre. The corn trial was harvested at an average 40.0% dry matter content (60.0% moisture). Dry summer and early fall conditions resulted in a rapid dry-down of corn silage crops in the area.

Table 4. Population, yield, and dry matter content of ten BMR varieties, Alburgh, VT, 2012.

Variety	RM	Yield at 35% DM
		tons ac^{-1}
F2F298	88-90	17.5
F2F343	92	18.7*
SW3737	94	12.7
F2F387	95	17.2
F2F488	98	24.2*
F2F569	104	20.2*
SW5555	104	13.8
F2F626	108	24.3*
F2F665	109	24.6*
P1376XR	113	**24.8***
LSD (0.10)		6.2
Trial mean		19.8

Treatments indicated in **bold** had the top observed performance.

* – Treatments indicated with an asterisk did not perform significantly worse than the top-performing treatment in a particular column.

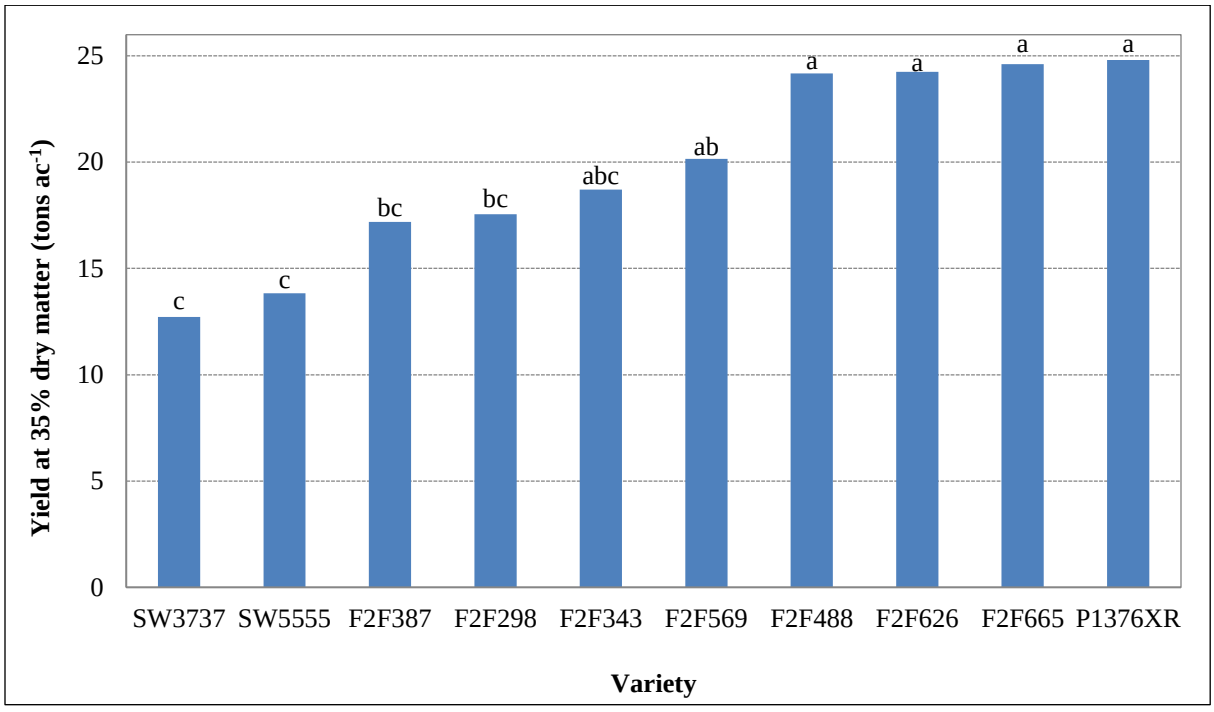

Figure 1. Yields of ten BMR corn silage varieties, Alburgh, VT, 2012. Treatments with the same letter did not differ significantly (p=0.10).

The majority of forage quality characteristics analyzed did vary significantly by BMR corn variety (Table 5). There was no significant difference in crude protein (CP) among varieties, and the trial mean was 8.1%. Acid detergent fiber (ADF), a measure of difficult-to-digest fiber content, and neutral detergent fiber (NDF), which is related to dairy cow feed intake, were both lowest in the variety P1376XR (24.3% and 42.8%, respectively), though not statistically lower than four other varieties (F2F343, F2F298, F2F626, and F2F488).

The percentage of NDF that is digestible in 30 hours (dNDF) was highest in the Mycogen varieties F2F387 (71.6%), and F2F488 (73.4%). Starch varied significantly by variety, with the greatest values in P1376XR, F2F626, F2F343, F2F298, F2F665, and F2F488. The content of nonfiber carbohydrates (NFC) and nonstructural carbohydrates (NSC) was greatest in P1376XR, F2F626, F2F343, F2F298, F2F665, and F2F488. Total digestible nutrients (TDN) varied significantly by variety; the greatest TDN content was observed in P1376XR, F2F626, F2F343, F2F298, F2F387, F2F665, and F2F488.

Table 5. Forage quality of ten evaluated BMR corn varieties, Alburgh, VT, 2012.

Variety	Forage quality characteristics									Milk	
	CP	ADF	NDF	dNDF	Starch	NFC	NSC	TDN	NE_L	ton^{-1}	ac^{-1}
	% of DM	% of DM	% of DM	% of NDF	% of DM	% of DM	% of DM	% of DM	Mcal lb^{-1}	lbs	lbs
F2F298	8.1	25.5*	45.1*	69.6	29.2*	42.8*	30.4*	71.9*	0.75	3237*	19859
F2F343	8.5	25.0*	44.6*	70.1	29.8*	42.8*	30.8*	72.2*	0.75	3245*	21155*
SW3737	8.0	29.4	51.8	68.6	22.1	35.2	23.7	69.0	0.72	3004	13361
F2F387	7.7	28.9	50.9	**73.4***	23.7	37.8	25.0	70.5*	0.73	**3296***	19740
F2F488	8.3	26.5*	46.8*	71.6*	25.7*	40.7*	27.5*	71.6*	0.75	3250*	**27907***
F2F569	8.1	28.7	50.8	70.2	22.7	36.6	24.3	69.7	0.73	3139*	22185*
SW5555	8.0	28.8	51.2	66.4	23.0	35.1	24.4	68.8	0.71	2851	13907
F2F626	7.4	26.5*	46.5*	67.3	30.3*	41.7*	31.2*	72.1*	0.75	3091	26242*
F2F665	7.8	27.4	48.4	67.3	27.9*	40.0*	28.9*	71.3*	0.74	3085	26612*
P1376XR	**9.0**	**24.3***	**42.8***	66.7	**30.6***	**43.8***	**32.3***	**72.4***	**0.76**	3125*	27081*
LSD (0.10)	NS	2.9	4.9	3.0	5.5	5.2	5.3	2.4	NS	183	7391
Trial mean	8.1	27.1	47.9	69.1	26.5	39.6	27.8	70.9	0.74	3132	21805

Treatments indicated in **bold** had the top observed performance.

* – Treatments indicated with an asterisk did not perform significantly worse than the top-performing treatment in a particular column.

NS – No significant difference was determined between treatments.

The amount of milk per ton of feed was calculated to be highest in F2F387 (3296 lbs per ton), though this was not statistically higher than the values for P1376XR, F2F488, F2F343, F2F298, or F2F569 (Figure 2). Milk per acre, an indicator of both yield and quality, was highest in the variety F2F488 (27907 lbs per acre). This was not statistically greater than the values for P1376XR, F2F665, F2F626, F2F569, or F2F343. Figure 2 displays the relationship between milk per ton and milk per acre, and includes dotted lines to represent the trial averages. Varieties that fall above or to the right of the lines performed better than the trial average, and varieties in the upper right quadrant of the figure were above-average in both milk per ton and milk per acre.

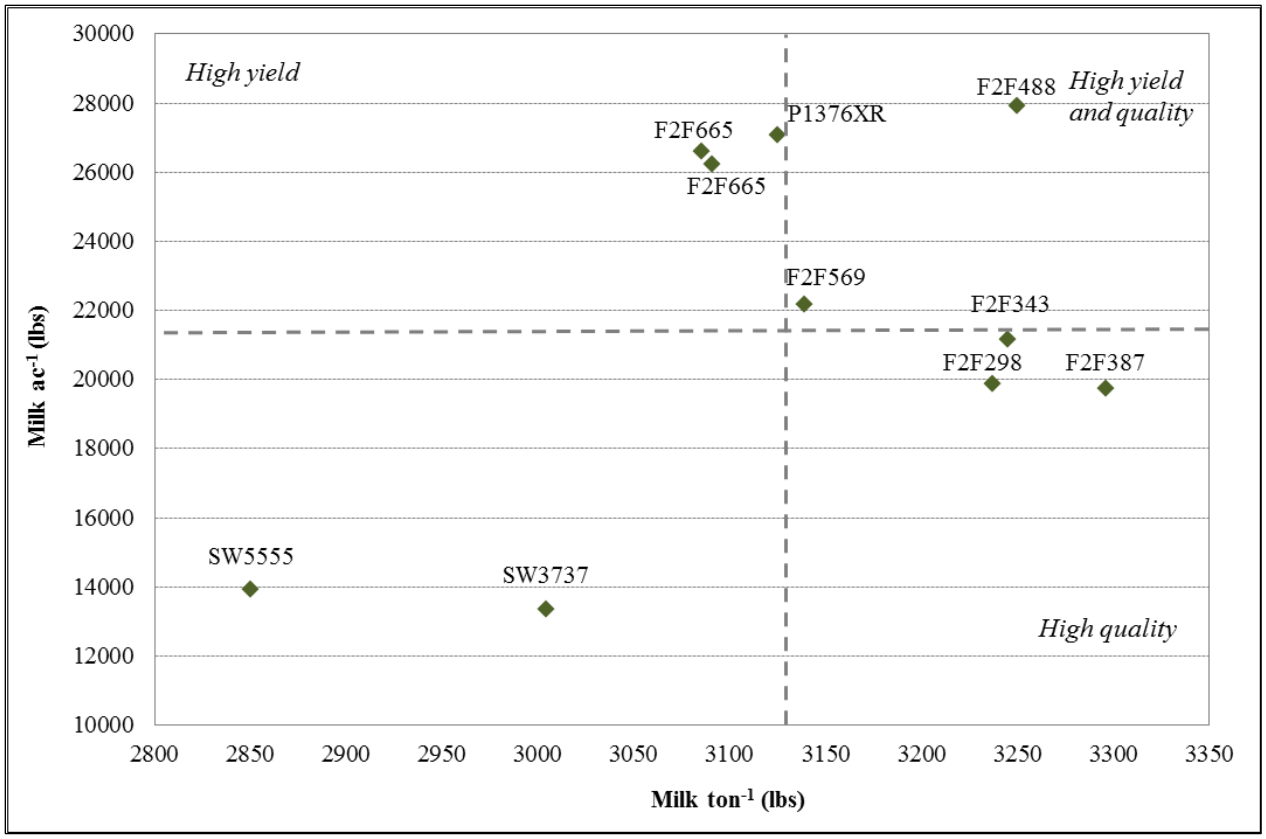

Figure 2. Milk production of ten BMR corn silage varieties, Alburgh, VT, 2012, showing relationship between milk per ton and milk per acre. Dotted lines represent the mean milk per ton and milk per acre for the location.

DISCUSSION

The average yield for this BMR corn trial was 19.8 tons per acre at 35% dry matter content. This is higher than the trial average in 2011 (18.6 tons per acre) and above average in general, perhaps due to the favorable growing conditions of the season. Though a drought hit Vermont in mid-summer, the growing season overall was favorable for corn silage. While BMR corn can have a yield drag when compared to conventional silage corn varieties in a given year, its higher NDF digestibility (dNDF) often makes it a viable choice for growers looking to maximize milk production. The 2012 trial average for dNDF, 69.1% of NDF, is on the high end for typical corn silage.

Though crude protein did not vary significantly by variety, all other corn quality indicators differed significantly by variety. Milk per ton was highest in the variety F2F387, though not statistically higher than the milk per ton value of F2F488, P1376XR, F2F343, F2F298, and F2F569. Milk per acre, which takes yield into consideration, is a more reliable indicator of milk production for a variety, and was highest in F2F488, P1376XR, F2F665, F2F626, F2F569, and F2F343. This is not surprising, as all of these varieties were also among the top-performers for yield.

It is important to note that these results, while significant, represent only one year of data at only one location. Consult additional research before making varietal selections or other agronomic decisions.

ACKNOWLEDGEMENTS

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