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## Brown Mid-Rib Corn Population Trial

Heather Darby

*University of Vermont*, [heather.darby@uvm.edu](mailto:heather.darby@uvm.edu)

Laura Madden

*University of Vermont*

Conner Burke

*University of Vermont*

Erica Cummings

*University of Vermont*

Hannah Harwood

*University of Vermont*

*See next page for additional authors*

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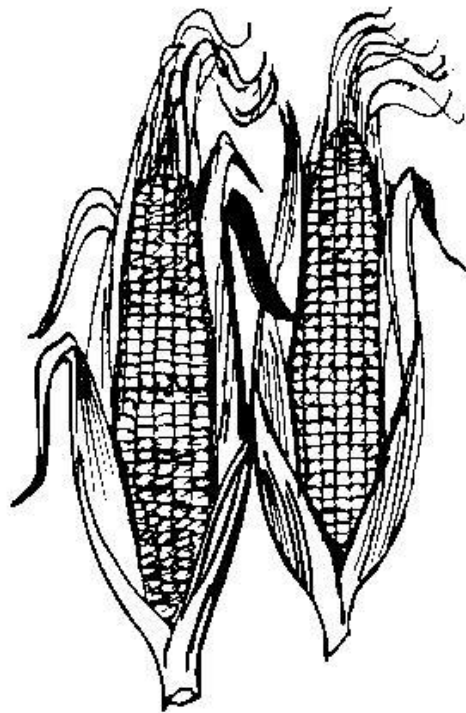
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**Authors**

Heather Darby, Laura Madden, Conner Burke, Erica Cummings, Hannah Harwood, and Susan Monahan



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Dr. Heather Darby, UVM Extension Agronomist  
Laura Madden, Conner Burke, Erica Cummings, Hannah Harwood, and Susan Monahan  
UVM Extension Crops and Soils Technicians  
(802) 524-6501

Visit us on the web at <http://www.uvm.edu/extension/cropsoil>

## **2013 BROWN MID-RIB CORN POPULATION TRIAL**

**Heather Darby, University of Vermont Extension**

[heather.darby\[at\]uvm.edu](mailto:heather.darby@uvm.edu)

Brown mid-rib (BMR) corn hybrids are of interest to many growers in the Northeast who would like to maximize milk production on homegrown forage. BMR corn has a naturally-occurring genetic mutation that leads to less lignin in the stalk and makes corn silage more digestible. Corn yields can be highly dependent on population, and it is generally recommended to plant BMR corn at lower populations than conventional silage corn. BMR corn has always been considered to be more prone to lodging due to its lower lignin content, and lower populations allow for less stress on each individual plant. However, optimal populations for the Northeast have yet to be developed. With this in mind, the University of Vermont Extension Northwest Crops & Soils Program conducted a field experiment in 2013 designed to evaluate the yield and quality performance of a BMR corn hybrid at three different populations across two different varieties. The data presented are only representative of one year, but this information can be combined with other research to aid in making agronomic decisions for BMR corn in the Northeast.

### **MATERIALS AND METHODS**

A trial was conducted at Borderview Research Farm in Alburgh, Vermont in 2013 in order to evaluate yield and quality of BMR corn grown at three plant densities across two varieties. The soil was a Benson rocky silt loam, and the area was previously planted with silage corn (Table 1). The experimental design was a randomized block of 10' x 250' plots, with three replications. Treatments were three populations (32,000, 36,000, and 40,000 plants per acre). The seedbed was prepared with spring disking and finished with a spike tooth harrow. The corn was planted in 30" rows on 9-May with a John Deere 1750 four-row corn planter. All corn was planted at 45,000 seeds per acre and plots were thinned by hand on 6-Jul to reach population targets. The varieties were Pioneer 'P1449XR' and Pioneer 'P1376XR' which have relative maturities of 114 and 113 days respectively. Both varieties have the following traits: Herculex XTRA® (HXX), which combines Herculex I and Herculex RW traits to provide season-long control of insects; Glufosinate-ammonium (LibertyLink®) herbicide tolerance; and Roundup Ready glyphosate (Roundup®, Touchdown®) herbicide tolerance.

A 10-20-20 starter fertilizer was applied at 200 lbs per acre at the time of planting. On 6-Jun, 3 pints per acre of the selective herbicide Lumax® (S-Metolachlor, atrazine, and mesotrione) and 0.33 ounces per acre Dupont Accent® (Nicosulfuron) were applied to control weeds. Urea fertilizer (46-0-0) was applied as a sidedress at 200 lbs per acre on 20-Jun. Corn was harvested on 10-Oct with a John Deere two-row chopper, and whole-plant silage was collected and weighed in a forage wagon fitted with scales. An approximate one pound subsample of chopped corn was collected for forage quality analysis.

**Table 1. Agronomic practices for the 2013 BMR corn population trial at Borderview Research Farm, Alburgh, VT.**

<b>Location</b>	<b>Borderview Research Farm – Alburgh, VT</b>
<b>Soil type</b>	Benson rocky silt loam
<b>Previous crop</b>	Silage corn
<b>Tillage operations</b>	Fall chisel plow, spring disk, spike tooth harrow
<b>Plot size (ft.)</b>	10 x 250
<b>Replications</b>	3
<b>Variety</b>	Pioneer P1449XR, P1376XR
<b>Population treatments</b>	32,000; 36,000; and 40,000 plants ac <sup>-1</sup>
<b>Row width (in.)</b>	30
<b>Planting date</b>	9-May
<b>Starter fertilizer</b>	200 lbs ac <sup>-1</sup> 10-20-20
<b>Additional fertilizer</b>	200 lbs ac <sup>-1</sup> Urea (46-0-0), 20-Jun
<b>Herbicide</b>	3 qt ac <sup>-1</sup> Lumax®, 0.33 oz ac <sup>-1</sup> Accent®, 6-Jun
<b>Harvest date</b>	10-Oct

Silage quality was analyzed using wet chemistry at Dairyland Lab in Arcadia, WI. Plot samples were analyzed for crude protein (CP), starch, sugar, 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 24-hour digestibility (NDFD). Evaluation of forages and other feedstuffs for NDFD 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 NDFD. Forages with increased NDFD will result in higher energy values, and perhaps more importantly, increased forage intakes. Forage NDFD can range from 20–80%, and is typically higher in BMR corn than conventional silage corn. 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.

The silage performance indices of milk per acre and milk per ton were calculated using a model derived from the spreadsheet entitled, “MILK2006” 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 (LSDs) 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	<b>9.0*</b>
B	7.5*
C	6.0
LSD (0.10)	2.0

## RESULTS

Using data from a Davis Instruments Vantage Pro2 weather station at Borderview Research Farm in Alburgh, VT, weather data were summarized for the 2013 growing season (Table 2). The spring season started out very wet, with higher precipitation in May and June than the 30 year average. The wet spring resulted in a delay in planting for many growers. However, the rest of the summer and fall remained drier than usual. Temperatures through the growing season were similar to the historical average through September. The total Growing Degree Days (GDDs) for May-September at a base temperature of 50°F was 2,259. This was 14 more GDDs than the historical average.

**Table 2. Summarized weather data for 2013 – Alburgh, VT.**

Alburgh, VT	May	June	July	August	September
Average temperature (°F)	59.1	64	71.7	67.7	59.3
Departure from normal	2.7	-1.8	1.1	-1.1	-1.3

Precipitation (inches)	4.79	9.23 *	1.89	2.41	2.20
Departure from normal	1.34	5.54	-2.26	-1.50	-1.44
Growing Degree Days (base 50°F)	312	427	677	554	289
Departure from normal	113	-47	37	-27	-29

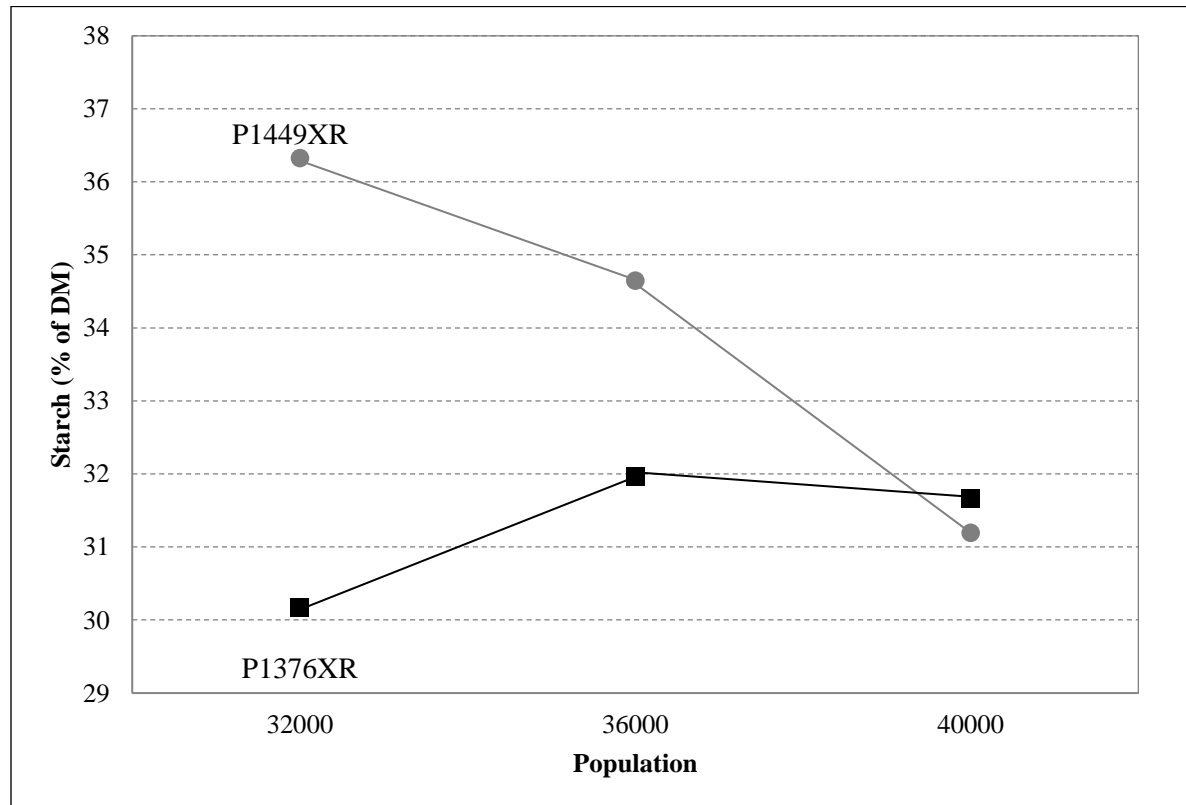
Based on weather data from a Davis Instruments Vantage Pro2 with Weatherlink data logger. Historical averages are for 30 years of NOAA data (1981-2010) from Burlington, VT.

\* June 2013 precipitation data based on National Weather Service data from cooperative stations in South Hero, VT.

### *BMR Variety by Plant Population Interactions*

There was a significant interaction between variety and plant population for starch concentrations. The variety P1376XR had the lowest percent starch at the population rate of 32,000 plants per acre (Figure 1). The percent of starch increased at the population rate of 36,000 plants per acre, and then slightly decreased when the population rate was as high as 40,000 plants per acre. The other variety, P1449XR, had the highest starch content when planted at a rate of 32,000 plants per acre. The starch content then decreased considerably as the population rate increased. Starch content is linked to the size of the ear on the corn plants. The level of starch may also indicate a higher ear to stover ratio for a variety. Generally higher plant populations result in lower smaller ears and hence less starch. This study indicates that BMR varieties may respond differently to plant population.

All other interactions between BMR corn variety and plant population did not differ significantly, indicating that BMR varieties respond similarly in yield and quality across plant populations.



**Figure 1. Effect of BMR corn variety and plant population on starch levels.**

### *Impact of BMR variety*

The variety with the highest yield at 35% dry matter was P1376XR (Table 3). However, this did not differ significantly from P1449XR.

**Table 3. Yield and dry matter content in BMR corn by variety, Alburgh, VT, 2013.**

Variety	Yield at 35% DM tons ac <sup>-1</sup>	DM at harvest %
P1376XR	<b>27.2</b>	<b>37.3</b>
P1449XR	23.7	36.8
LSD (0.10)	NS	NS
Trial mean	25.1	37.0

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

NS – No significant difference was determined between treatments.

There were few significant differences in quality between the two varieties evaluated in this study. The variety P1376XR had the highest CP concentrations and NDFD (24-hour). However, these percentages did not differ significantly from the other variety (Table 4). P1449XR had the lowest NDF, but there was no statistically significant difference between the varieties. P1449XR also had a higher percent sugar and percent starch than P1376XR. However, only the starch differed significantly between the varieties.

The amount of milk per ton was almost the same for both varieties. Milk per acre, which takes into account both yield and quality, was higher in P1376XR with 34,502 tons per acre. However, this difference was not significantly different from P1449XR.

**Table 4. Effects of variety on BMR corn quality, Alburgh, VT, 2013.**

Variety	Forage quality characteristics					Milk	
	CP	NDF	NDFD	Starch	Sugar	ton <sup>-1</sup>	ac <sup>-1</sup>
	% of	% of	% of	% of	% of		
	DM	DM	DM	DM	DM	lbs	lbs
P1376XR	<b>6.5</b>	41.1	<b>54.3</b>	31.3	8.66	<b>3629</b>	<b>34502</b>
P1449XR	6.0	<b>38.7</b>	52.4	<b>34.1*</b>	<b>8.74</b>	3628	30118
LSD (0.10)	NS	NS	NS	1.9	NS	NS	NS
Trial mean	6.2	39.6	53.1	32.9	8.71	3628	31872

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.

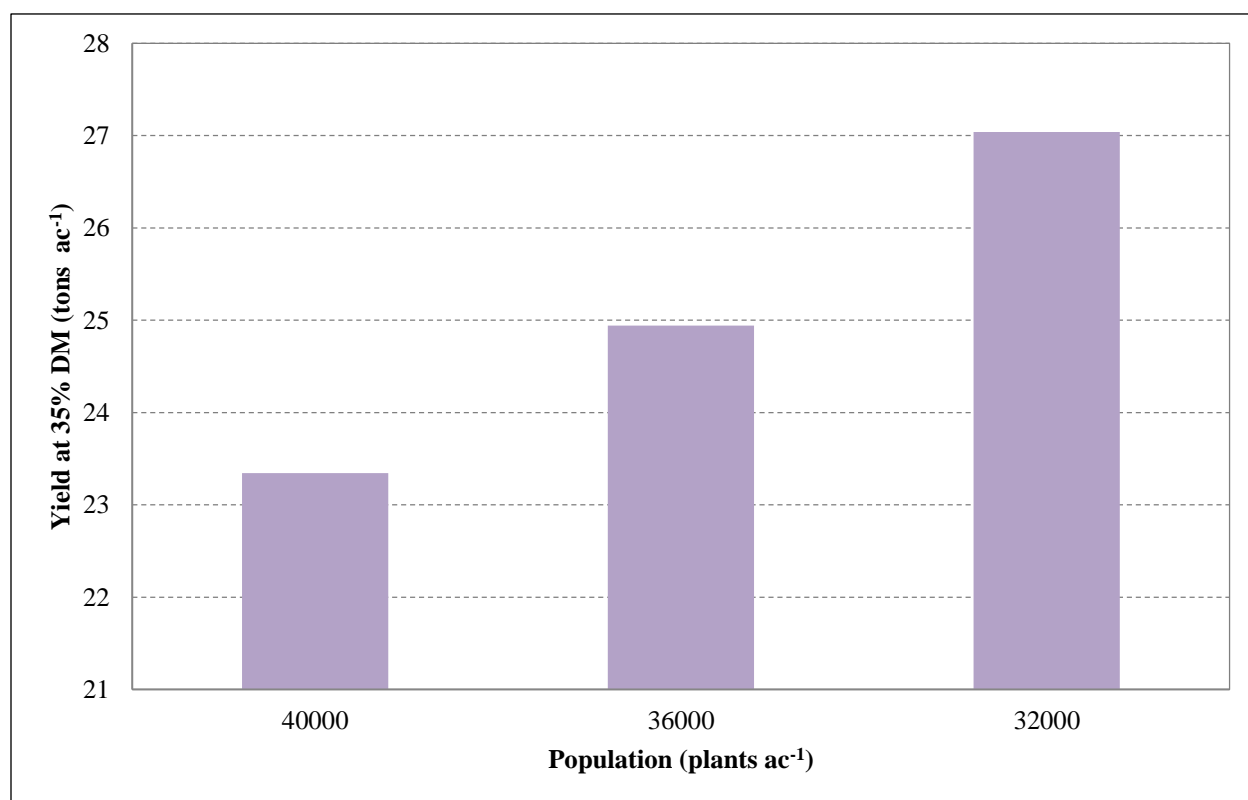
### *Impact of plant population*

In this trial the population rates 32,000, 36,000 and 40,000 plants per acre were assessed. While not statistically significant, there is a notable trend wherein as plant population decreases, the yield at 35% dry matter increases (Figure 2). The highest yield at 35% dry matter was 27 tons per acre at the population rate 32,000 plants per acre (Table 5). This does not differ significantly from the other population rates. The average yield at 35% dry matter was 25 tons per acre.



**Table 5. Yield and dry matter content in BMR corn by population, Alburgh, VT, 2013**

Population plants ac <sup>-1</sup>	Yield at 35% DM tons ac <sup>-1</sup>	DM at harvest %
32,000	<b>27.0</b>	36.9
36,000	24.9	<b>37.6</b>
40,000	23.3	36.4
LSD (0.10)	NS	NS
Trial mean	25.1	37.0



**Figure 2. Effect of population on BMR corn yield. There was no significant difference between population rates (p=0.10).**

In general, 32,000 plants per acre had the best quality characteristics (Table 6). Plots planted at 32,000 plants per acre showed the highest CP, NDFD and starch concentrations. They also showed the lowest percent NDF and the highest amount of milk per ton and milk per acre. However, these high values were not significantly different from any of the other measurements taken for the populations 36,000 and 40,000 plants per acre.

**Table 6. Effects of population on BMR corn quality, Alburgh, VT, 2013.**

Population plants ac <sup>-1</sup>	Forage quality characteristics					Milk	
	CP	NDF	NDFD	Starch	Sugar	ton <sup>-1</sup>	ac <sup>-1</sup>
	% of DM	% of DM	% of DM	% of DM	% of DM	lbs	lbs
32,000	<b>6.5</b>	<b>38.6</b>	<b>53.7</b>	<b>33.9</b>	8.62	<b>3678</b>	<b>34722</b>
36,000	6.3	39.2	52.7	33.6	8.48	3620	31582
40,000	5.7	41.0	53.0	31.4	<b>9.02</b>	3588	29311
LSD (0.10)	NS	NS	NS	NS	NS	NS	NS
Trial mean	6.2	39.6	53.1	32.9	8.71	3628	31872

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

NS – No significant difference was determined between treatments.

## DISCUSSION

Yield and quality indicators did not vary significantly between population treatments in this trial. However, there was a tendency towards higher yields and quality in BMR corn grown at lower populations of 32,000 plants per acre. Yield at 35% dry matter was 27 tons per acre for the population rate 32,000 per acre. This was only 1.9 tons higher than the trial average (25.1 tons per acre).

In general, yield and quality indicators also did not vary significantly between varieties. There was only a significant difference in levels of starch between the varieties P1449XR and P1376XR (34.1% and 31.3% respectively). For more information regarding yields and quality of different BMR corn varieties, please see the 2013 Brown Mid-Rib Corn Variety Trial report, available online at <http://www.uvm.edu/extension/cropsoil>.

Percentage of starch also differed significantly when both variety and population treatment were considered. For the variety P1449XR, as the population decreased, the starch increased. At 40,000 plants per acre the starch was 31.2%, and at 32,000 plants per acre the starch was 36.3%. For the variety P1376XR, as the population increased from 32,000 plants per acre to 36,000 plants per acre, starch levels increased. However, at 40,000 plants per acre, the percent starch decreased slightly. Thus, the highest percent starch for the variety P1376XR was 32% for 36,000 plants per acre. It is possible that the lower populations allowed more room for ears to grow, resulting in bigger ears of corn. This would have resulted in a higher percentage of starch. Further research needs to be conducted across multiple years and sites to determine the best plant population for BMR corn production in this region.

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