



## 2021 Grain Corn Variety x Seeding Rate



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**2021 GRAIN CORN VARIETY X SEEDING RATE TRIAL**  
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In the Northeast there is a strong demand from consumers to have access to a wide range of locally produced food products. This demand creates opportunities for specialty value-added markets and crops to emerge. One market that has been gaining popularity and expanding recently in the Northeast is the specialty corn market. Flint corn has very hard starch and can be ground and used in tortillas, tamales, corn meal, grits, and other products. Flint has a high proportion of hard starch in the kernel that produces a coarse meal. This is different than a soft-starch flour corn that, when ground, results in a fine flour. Dent corn is similar as it has a lower proportion of hard starch than flint corn, and thus forms a small dent on top of each kernel when mature (Figure 1). Flint and flour corn types, although recorded as being grown by Native Americans, have largely not been produced on a commercial scale in this region. However, new food entrepreneurs are looking to source local grain corn, producing potential value-added markets for local farmers. Therefore, it is important to evaluate both commercially available and locally saved flint, flour, and dent corn varieties to determine varieties that are well suited to our northern climate and production practices that produce economically viable yields and meet the quality expectations of this new market.

The University of Vermont Extension Northwest Crops and Soils Program conducted a grain corn variety x seeding rate trial in 2021 to evaluate commercially available flint and heirloom dent corn varieties planted at varying seeding rates for yield, quality, and suitability to our northern climate. It is important to remember that the data presented are from a replicated research trial from only one location in Vermont and represent only one season. Crop performance data from additional tests in different locations and over several years should be compared before making varietal selections or altering production practices.

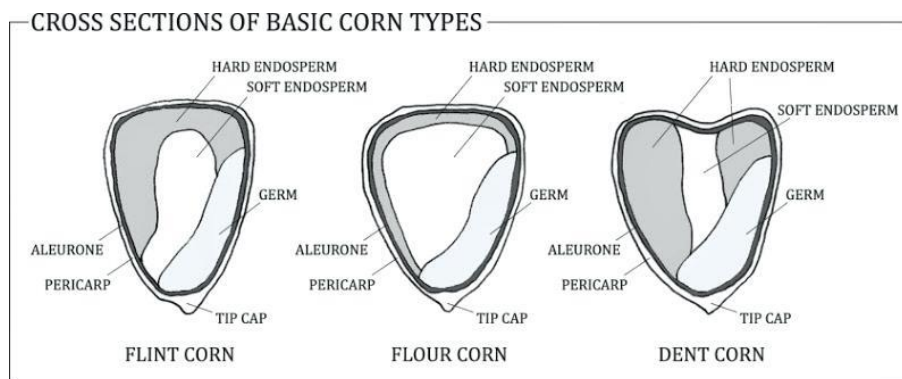


Figure 1. Difference in starch composition of grain corn types (Burton & Fincher, 2014).

## MATERIALS AND METHODS

In 2021, two grain corn varieties, one flint and one heirloom dent, were each seeded at six different seeding rates at Borderview Research Farm in Alburgh, Vermont (Table 1). The trial design was a randomized complete block with split plots and four replications. Main plots were the varieties while sub-plots were seeding rates ranging from 20,000 to 30,000 seeds  $ac^{-1}$ . Plots were evaluated for populations, lodging, grain yield, grain moisture, and grain test weight. The soil type at the Alburgh location is a Covington silty clay loam. The seedbed was prepared with a Pottinger TerraDisc. The previous crop was corn silage. Prior to

planting, plots were fertilized with 19-19-19 at a rate 300 lbs ac<sup>-1</sup> on 6-Apr. Plots were planted on 24-May with a 4-row cone planter with John Deere row units fitted with Almaco seed distribution units (Nevada, IA). Liquid starter fertilizer (9-18-9) was applied at planting at a rate of 5 gal ac<sup>-1</sup>. Plots were 20' long and consisted of four rows of corn 30" apart. Populations were counted in each plot after emergence prior to harvest. An application of Acuron was made on 4-Jun at a rate of 3 qt ac<sup>-1</sup> to control weeds. On 7-Jul, plots were top-dressed with 400 lbs ac<sup>-1</sup> 24-12-18.

**Table 1. Treatment and trial management information.**

<b>Location</b>	<b>Borderview Research Farm- Alburgh, VT</b>
Soil type	Covington silty clay loam
Previous crop	Corn silage
Row width (in)	30
Plot size (ft)	10 x 20
Varieties	Cascade Ruby-Gold (flint type) Wapsie Valley (dent type)
Seeding rates (seeds ac <sup>-1</sup> )	20,000
	22,000
	24,000
	26,000
	28,000
Planting date	30,000
	24-May
Tillage operations	Pottinger TerraDisc
Weed control	3 qt ac <sup>-1</sup> Acuron 4-Jun
Harvest dates	8-Oct (Cascade Ruby-Gold)
	5-Nov (Wapsie Valley)

On 8-Oct and 5-Nov the Cascade Ruby Gold and Wapsie Valley plots were harvested respectively. Corn populations and the number of barren plants, plants that did not form an ear, were counted. Plots were also visually assessed for lodging severity on a scale from 0 (no lodging) to 5 (completely lodged). Corn was picked by hand and fed through an Almaco SPC50 plot combine. The corn from each plot was weighed and the moisture and test weight measured using a Dickey John Mini-GAC Plus moisture and test weight meter.

Yield data and stand characteristics were analyzed using mixed model analysis using the mixed procedure of SAS (SAS Institute, 1999). Replications within trials were treated as random effects, and hybrids were treated as fixed. Hybrid mean comparisons were made using the Least Significant Difference (LSD) procedure when the F-test was considered significant ( $p < 0.10$ ). Variations in yield and quality can occur due to variations in genetics, soil, weather, and other growing conditions. Statistical analysis makes it possible to determine whether a difference among hybrids is real or whether it might have occurred due to other variations in the field. At the bottom of each table a LSD value is presented for each variable (i.e. yield). Least Significant Differences (LSDs) at the 0.10 level of significance are shown. Where the difference between two hybrids within a column is equal to or greater than the LSD value at the bottom of the column, you can be sure that for 9 out of 10 times, there is a real difference between the two hybrids.

Hybrids that were not significantly lower in performance than the highest hybrid in a particular column are indicated with an asterisk. In this example, hybrid C is significantly different from hybrid A but not from hybrid B. The difference between C and B is equal to 1.5, which is less than the LSD value of 2.0. This means that these hybrids did not differ in yield. The difference between C and A is equal to 3.0, which is greater than the LSD value of 2.0. This means that the yield of these hybrids were significantly different from one another. The asterisk indicates that hybrid B was not significantly lower than the top yielding hybrid C, indicated in bold.

Hybrid	Yield
A	6.0
B	7.5*
C	<b>9.0*</b>
LSD	2.0

## RESULTS

Weather data was recorded with a Davis Instrument Vantage Pro2 weather station, equipped with a WeatherLink data logger at Borderview Research Farm in Alburgh, VT (Table 2). Temperatures were above normal in all months except for July which experienced temperatures more than four degrees below normal. Rainfall was below normal through August with September being approximately normal and October receiving more than two inches above normal. Overall, the region was classified as being in abnormally dry or moderate drought conditions for the majority of the season (Drought.gov). These conditions also brought more Growing Degree Days (GDDs) with a total of 2496 being accumulated through the growing season, 110 above the 30-year normal.

**Table 2. Weather data for Alburgh, VT, 2021.**

Alburgh, VT	June	July	August	September	October
Average temperature (°F)	70.3	68.1	74.0	62.8	54.4
Departure from normal	2.81	-4.31	3.25	0.14	4.07
Precipitation (inches)	3.06	2.92	2.29	4.09	6.23
Departure from normal	-1.20	-1.14	-1.25	0.42	2.40
Growing Degree Days (50-86°F)	597	561	727	394	217
Departure from normal	73	-134	85	7	79

Based on weather data from a Davis Instruments Vantage Pro2 with WeatherLink data logger. Historical averages are for 30 years of NOAA data (1991-2020) from Burlington, VT.

### *Impact of Variety*

The two varieties in the trial differed significantly in the proportion of plants that were barren and in lodging severity, but performed statistically similarly in all other measures including yield (Table 3). The Cascade Ruby-Gold variety had approximately twice the number of barren plants compared to the Wapsie Valley, totaling over 1000 plants ac<sup>-1</sup>. This accounted for approximately 5% of Cascade Ruby-Gold plants. The two varieties, across all seeding rates, established an average of 20,274 plants ac<sup>-1</sup> and did not differ statistically. In addition to barren plants, the Cascade Ruby-Gold variety experienced significantly higher lodging severity. While no lodging was observed in the Wapsie Valley plots, on average the Cascade Ruby-Gold plots had a lodging severity of 2.25 on a scale from 0-5. Lodging prior to harvest can leave ears vulnerable to damage from pests and rot while also increasing the potential for greater harvest losses as some lodged stalks may leave ears too low to combine easily. Despite this, both varieties yielded well producing an average of 4569 lbs ac<sup>-1</sup> or 81.6 bu ac<sup>-1</sup> when adjusted to 13% moisture. The varieties did not differ in the moisture content at harvest or kernel test weight. Both varieties required additional drying to reduce kernel moisture to safe

storage levels and had test weights below the industry standard for shell corn of 56 lbs bu<sup>-1</sup>. This was likely due to dry conditions throughout the season, especially during critical developmental stages including pollination and seed fill.

**Table 3. Harvest characteristics of two specialty corn varieties, 2021.**

Variety	Populations plants ac <sup>-1</sup>	Barren plants	Lodging 0-5 scale	Harvest moisture %	Test weight lbs bu <sup>-1</sup>	Yield at 13% moisture	
						lbs ac <sup>-1</sup>	bu ac <sup>-1</sup>
Cascade Ruby-Gold	<b>20564</b>	1016	2.25	22.3	53.2	<b>4776</b>	<b>85.3</b>
Wapsie Valley	19983	<b>526</b>	<b>0.00</b>	<b>21.7</b>	<b>53.3</b>	4341	77.5
Level of significance	NS†	**‡	***§	NS	NS	NS	NS
Trial mean	20274	771	1.13	22.0	53.2	4569	81.6

†NS- not statistically significant

‡\*\* 0.05 < p > 0.01

§\*\*\*p < 0.0001

### *Impact of Seeding Rate*

Seeding rate did not significantly impact yield, test weight, lodging, or the proportion of barren plants (Table 4). The highest yield was obtained at a seeding rate of 26,000 plants ac<sup>-1</sup> but did not significantly differ from all other seeding rates including down to 20,000 plants ac<sup>-1</sup> and up to 30,000 plants ac<sup>-1</sup>. This suggests that, for these two corn varieties, no additional yield benefit is gained from increasing seeding rates beyond 20,000 plants ac<sup>-1</sup>. Plant populations differed significantly, which was intended. However, it is interesting to note the actual plant populations attained by each seeding rate. While seeding rates ranged from 20,000 to 30,000 plants ac<sup>-1</sup>, actual harvest populations ranged from 17,152 to 23,196 plants ac<sup>-1</sup>. While the actual populations attained in the trial followed the intended treatments on a relative basis, these data also suggest that these corn varieties may be even produce substantial yields when planted at rates less than 20,000 plants ac<sup>-1</sup>. Some of the discrepancy between the seeding rate and final plant population attained may have been due to the exceptionally dry conditions following planting and throughout the trial, which likely impacted germination and establishment.

**Table 4. Harvest characteristics of six seeding rates of grain corn, 2021.**

Seeding rate plants ac <sup>-1</sup>	Populations plants ac <sup>-1</sup>	Barren plants	Lodging 0-5 scale	Harvest moisture %	Test weight lbs bu <sup>-1</sup>	Yield at 13% moisture	
						lbs ac <sup>-1</sup>	bu ac <sup>-1</sup>
20,000	17152d†	599	1.13	22.3ab	53.3	5037	90.0
22,000	18785cd	708	1.00	22.5b	52.8	4814	86.0
24,000	19765c	762	1.25	22.3ab	52.5	4618	82.5
26,000	20637bc	871	1.25	22.5ab	54.6	5506	98.3
28,000	22107ab	980	1.13	22.6b	52.1	4914	87.8
30,000	23196a	708	1.00	20.2a	54.1	2924	52.2
Level of significance	***‡	NS	NS	**	NS	NS	NS
Trial mean	20274	771	1.13	22.0	53.2	4569	81.6

†Within a column, treatments with the same letter performed statistically similar.

‡Treatments were significantly different at the following p values \*\* 0.05 < p > 0.01; \*\*\*p < 0.0001.

§NS- not statistically significant.

## DISCUSSION

These two specialty grain corn varieties were selected for this trial due to their differences in growth characteristics and kernel starch types. Cascade Ruby-Gold is a short stature, flint corn while Wapsie Valley is a very tall dent corn. The flint corn had a greater potential to produce tillers and the dent corn had lower potential to produce tillers. We hypothesized that these characteristics may impact their response to plant population. Cascade Ruby-Gold had more barren plants and a higher percentage of plants lodged compared to the Wapsie Valley. However, despite this, both varieties yielded similarly (over 2 tons  $\text{ac}^{-1}$ ) and neither were impacted by plant population. Standard recommendations for modern dent corn varieties range from 26,000 to 28,000 plants per acre. In this study, seeding rates from 20,000 to 30,000 seeds  $\text{ac}^{-1}$  were planted, however, the final plant populations only ranged from 17,152 to 23,196 plants  $\text{ac}^{-1}$ . These data suggest that both flint- and dent-type corns may still produce significant yields at seeding rates lower than the recommended rates for modern grain. However, it is unclear if higher yields of flint and heirloom dent corn could be achieved at standard grain plant populations. Identifying optimum plant populations for flint and heirloom dent corn is critical to help farmers maximize yields of these high value corn types. As these data only represent two varieties planted at one location over one season, additional information should be consulted before making management decisions.

## REFERENCES

Burton, Rachel A., and Fincher, Geoffrey B. 2014. Evolution and Development of Cell Walls in Cereal Grains. *Frontiers in Plant Science* 5:456.

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