NORTHWEST CROPS & SOILS PROGRAM

2023 Impacts of Row Spacing and Seeding Rate on Flint Corn Performance

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2023 IMPACTS OF ROW SPACING AND SEEDING RATE ON FLINT CORN PERFORMANCE

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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 and row spacing trial in 2023 to evaluate production practice impacts on flint corn yields in northern climates. 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.

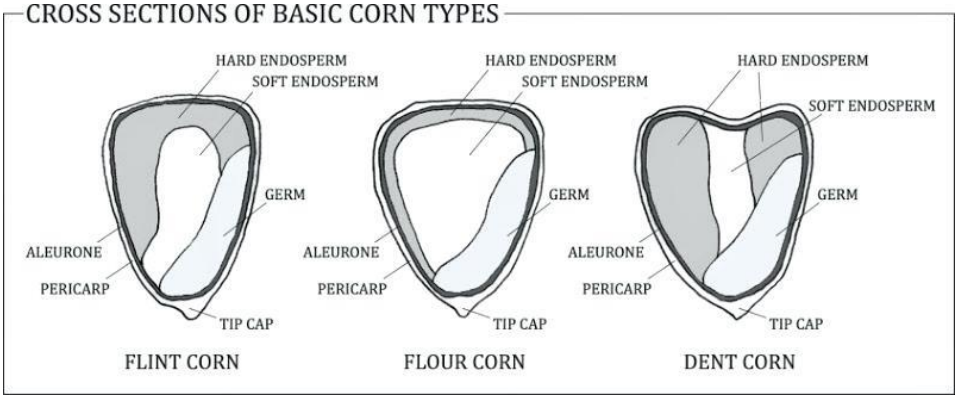

Figure 1. Difference in starch composition of grain corn types (Burton & Fincher, 2014).

MATERIALS AND METHODS

In 2023, two flint corn trials were initiated at Borderview Research Farm in Alburgh, Vermont (Table 1). The first trial investigated flint corn performance when planted at four row spacings. Conventional grain corn is typically planted in 30-inch rows at populations around 28,000 plants ac^{-1}. However, the varieties used don't produce tillers and therefore, higher yields are achieved by higher populations to a point. In the interest of increasing cover crop establishment, wider row spacings have been used in these systems to

increase cover crop performance while achieving adequate grain yields. Since flint corns often produce tillers, altering row spacing may be more advantageous to these varieties than conventional grain corn both for cover crop establishment but also achieving adequate yields on these wider row spacings. The trial design was a randomized complete block with six replications. Data were only collected on four of the replications. Plots all consisted of four rows planted at 28,000 seeds ac^{-1} and were 30 feet in length. Plots were planted on 26-May. In June, the plots were treated with Lumax herbicide to control weeds and were fertilized with urea. At harvest, plant populations and the number of barren plants were recorded in the center two rows of each plot. 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.

Table 1. Trial treatment and management information.

	Trial 1 (Row spacing)	**Trial 2 (Variety x seeding rate)**
Location	**Borderview Research Farm- Alburgh, VT**	
Soil type	Covington silty clay loam	Covington silty clay loam
Previous crop	Corn silage	Corn silage
Row widths (in)	30, 36, 40, 60	30
Varieties	Flint's flint (locally adapted selection)	Roy's Calais Flint (commercial variety) Flint's flint (locally adapted selection)
Seeding rates (seeds ac^{-1})	28,000	19,000 24,000
Planting dates	26-May	5-Jun
Tillage operations	Pottinger TerraDisc	Pottinger TerraDisc
Weed control	3 qt. ac^{-1} Lumax EZ 10-Jun	3 qt. ac^{-1} Lumax EZ 10-Jun
Fertilizer	250 lbs ac^{-1} urea w/ContainMax 20-Jun	250 lbs ac^{-1} urea w/ContainMax 20-Jun
Harvest date	17-Oct	17-Oct

The second trial investigated the performance of two varieties at two seeding rates on 30-inch rows. Similar to the row spacing trial, the lower populations may be advantageous for flint corn varieties that tend to produce tillers even on 30-inch rows compared to more convention non-tillering varieties. The trial design was a randomized complete block with split plots and three replications. Main plots were two varieties (one flint type, one dent type) while sub-plots were seeding rates of 19,000 and 24,000 seeds ac^{-1}. Plots were evaluated for populations, barren plants, grain yield, grain moisture, and grain test weight as described previously on 17-Oct.

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	**9.0***
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). Conditions early in the season were relatively warm and dry. However, after planting conditions turned cool and wet which persisted through the summer months. Excessive rainfall fell through July and August with 9.42 inches above normal precipitation accumulated during those two months alone. In general, temperatures were below normal and rainfall above normal June-August. In September and October up until harvest, conditions improved slightly with above normal temperatures and rainfall. Overall, the cool wet conditions provided 2265 Growing Degree Days (GDDs), 120 fewer than the 30-year normal. Despite the relatively poor growing conditions, the varieties in these two trials met physiological maturity and could be harvested prior to additional rainfall and frost.

Table 2. Weather data for Alburgh, VT, 2023.

Alburgh, VT	June	July	August	September	October
Average temperature (°F)	65.7	72.2	67.0	63.7	57.4
Departure from normal	-1.75	-0.24	-3.73	1.03	7.07
Precipitation (inches)	4.40	10.8	6.27	2.40	3.64
Departure from normal	0.14	6.69	2.73	-1.27	-0.19
Growing Degree Days (50-86°F)	408	712	540	449	156
Departure from normal	-116	17	-101	62	18

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.

Trial 1- Impact of Row Spacing

Plant populations differed statistically across the row spacing treatments with higher populations being achieved in the 30-inch rows (Table 3). However, more barren plants were observed in plots planted on 30-inch rows compared to the other spacings. In the end, these differences led to statistically similar yields across the treatments suggesting that flint corn yield was not impacted by row spacing. While numerically yields decreased slightly as row spacing was increased these differences were not statistically significant. Yields averaged 1778 lbs ac^{-1} or 32.6 bu ac^{-1} across the trial. Yields were relatively low for grain corn in this region and was likely impacted by the poor weather conditions during the summer.

Table 3. Performance of flint corn grown in four row spacings, 2023.

Row spacing	Kernel yield @13% moisture		Test weight	Plant populations	Barren plants	
	lbs ac^{-1}	bu ac^{-1}	lbs bu^{-1}	plants ac^{-1}	plants ac^{-1}	% of population
30-in	1921	35.0	**54.9**	**12923a**§	1670b	12.7
36-in	**2008**	**36.8**	54.6	9862b	**545a**	**6.10**
40-in	1750	32.1	54.5	10631b	830a	7.60
60-in	1433	26.5	54.3	8857b	980a	11.5
LSD (p=0.10) †	NS‡	NS	NS	2068	565	NS
Trial mean	1778	32.6	54.6	10568	1006	9.4

†Least significant difference at the p = 0.10 level. Top performer indicated in **bold.**

‡NS- not statistically significant.

§Treatments that share a letter performed statistically similarly to one another.

Trial 2- Impact of Variety and Seeding rate

The two varieties included in this trial performed differently in terms of yield and test weight (Table 4). Flint's flint yielded almost 1800 lbs ac^{-1} more than Roy's Calais flint. The yields equated to 75.6 and 38.7 bu ac^{-1} for Flint's flint and Roy's Calais flint respectively. However, the test weight for the Flint's flint was substantially lower than Roy's Calais flint. Standard test weight for dent corn is 56 lbs bu^{-1} and is typically indicative of adequate grain quality. While the Roy's Calais flint achieved this benchmark, the Flint's flint did not despite its superior yields. Although other aspects of grain quality were not measured in this trial, Flint's flint may have suffered from more disease or less kernel fill given the relatively poor growing conditions. Both varieties had similar rates of barren plants averaging approximately 10% of the total populations. There were no significant variety x seeding rate interactions suggesting that the varieties included in this trial both responded similarly to altering seeding rates.

Table 4. Harvest characteristics of two flint corn varieties, 2023.

Variety	Kernel yield @ 13% moisture		Test weight	Barren plants
	lbs ac^{-1}	bu ac^{-1}	lbs bu^{-1}	% of population
Flint's flint	**3975**	**75.6**	52.7	**9.59**
Roy's Calais flint	2180	38.7	**56.4**	10.3
LSD (p=0.10) †	340	10.4	0.848	NS‡
Trial mean	3078	57.1	54.5	9.94

†Least significant difference at the p = 0.10 level. Top performer indicated in **bold.**

‡NS- not statistically significant.

Seeding rate did not significantly impact yield, test weight, or the proportion of barren plants (Table 5). The highest yield was obtained in the 19,000 seeds ac^{-1} treatment but did not significantly differ from the higher seeding rate. This indicates that no additional yield benefit was gained from planting these flint corn varieties above 19,000 seeds ac^{-1}. These data are consistent with previous findings in both heirloom flint and dent type corns in Vermont.

Table 5. Harvest characteristics of two seeding rates of flint corn, 2023.

Seeding rate	Kernel yield @ 13% moisture		Test weight	Barren plants
seeds ac^{-1}	lbs ac^{-1}	bu ac^{-1}	lbs bu^{-1}	% of population
19,000	**3156**	**59.0**	54.3	**8.19**
24,000	2999	55.3	**54.7**	11.7
LSD (p=0.10) †	NS‡	NS	NS	NS
Trial mean	3078	57.1	54.5	9.94

†Least significant difference at the p = 0.10 level. Top performer indicated in **bold.**
‡NS- not statistically significant.

DISCUSSION

These two flint corn varieties were selected for this trial due to their flinty kernel characteristics and their local adaptation to the Vermont climate. Roy's Calais flint is an open pollinated variety that originated with the Abenaki peoples of Vermont. Flint's flint is a locally adapted selection from a synthetic population developed from crossing a number of historic northern flints. Both varieties produce relatively tall plants with some tillers and long 8-10 row ears. We hypothesized that these characteristics may impact their responses to altering seeding rates and row spacings, potentially requiring different practices from typical grain corn production practices. Flint's flint did not produce different yields when planted at row widths varying from 30- to 60-inches. Neither variety produced different yields when seeding rates were increased beyond 19,000 seeds ac^{-1}. These data suggest that flint type corns may still produce significant yields at seeding rates as low or lower than 20,000 plants ac^{-1}. In addition, as long as populations can be maintained, significant yield impacts are not observed as row spacings are increased up to 60-inches. 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.

ACKNOWLEDGEMENTS

UVM Extension Northwest Crops and Soils Program would like to thank Roger Rainville and the staff at Borderview Research Farm for their generous help with this research trial as well as Lindsey Ruhl and Laura Sullivan for their assistance with data collection and entry. The information is presented with the understanding that no product discrimination is intended and no endorsement of any product mentioned or criticism of unnamed products is implied.

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