2022-2023
Spreckels Sugar
RESEARCH REPORT

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2022-2023 Sugar Beet Emergence Utilizing Furrow and Sprinkler Irrigation - Field Data Project

Mark Bloomquist, Dimitri Boratynski, and Joaquin Santiago
Spreckels Sugar Company Inc.

Justification:

The Imperial Valley climate can be very severe for the emergence of seedling sugar beet plants. The daily high temperatures in September are often in excess of 100 degrees F. In addition to these temperatures, many of the soils in the Imperial Valley have salt levels that can create emergence issues for small-seeded crops. Traditionally, sugar beet is furrow irrigated in the Imperial Valley. However, there has been increasing interest in utilizing solid set sprinkler pipe during the germination and emergence period and then converting the field to furrow irrigation once the sugar beet stand is established. This project was developed to quantify if there are emergence differences between these two irrigation methods. If differences exist, do these differences equate to a root yield and quality difference at harvest?

Objective:

The objective of this project is to determine if an advantage exists to sprinkler irrigation versus furrow irrigation during the germination and emergence period. Comparisons will include emergence percent, root yield, and quality. The project will create and utilize a database of 2022-2023 Imperial Valley sugar beet fields to gather data and analyze differences between the two types of irrigation.

Material and Methods:

This project is a collection of data from current year production fields in the Imperial Valley of California. The Agricultural Team at Spreckels Sugar collected stand counts on 80 sugar beet fields in September – November 2022. Figure 1 is a map of the field locations and sample points included in the project. The black stars represent the field locations and sample points. Within each field, the Agriculturists were instructed to collect 20 stand counts scattered throughout the field. The stand counts consisted of counting all the emerged sugar beets in 10 feet of row per sampling location in the field. The stand counts were averaged on a field basis to establish the sugar beet population for every field in the database. The average stand count per field was used to calculate each field's percent emergence. In addition to the stand counts, the Agriculturists collected the following information from the growers for each field: variety, seed spacing, planting date, first water date, and sprinkler or furrow irrigation. All this information was input into the ArcGIS Collector App (ESRI), allowing the spatial display of the field locations. The data was exported into Excel (Microsoft Corp.) for analysis.

During the harvest season, Spreckels Sugar Agriculturists measured all partially harvested fields weekly to obtain a weekly root yield and quality for each field and a weekly yield average for the company. Weekly yield information for each irrigation project field was added to the sprinkler/furrow irrigation database. The weekly root yield and quality data allowed yield comparison and revenue per acre calculations for sprinkler and furrow irrigated fields.

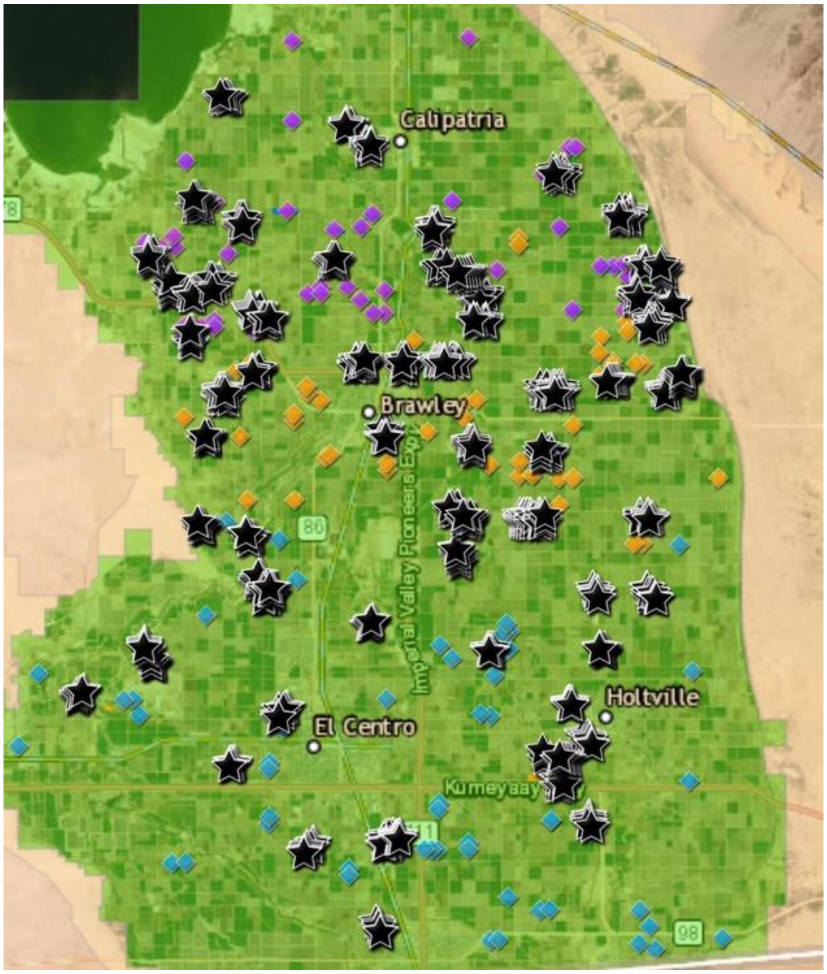

Figure 1. Map of field locations included in the 2023-2023 irrigation project.

Results:

Harvest began on April 13, 2023, at Spreckels Sugar. Weekly harvest data was accumulated and summarized starting on April 17, 2023. Fields included in the irrigation project were summarized each week by irrigation type for emergence percent, yield parameters, and estimated revenue per acre for the harvested acreage. Since September can have the most challenging conditions for sugar beet emergence, the fields planted in September were the fields utilized in the data to be presented. The weekly results are the average of the fields harvested each week for each irrigation type. Table 1 compares sprinkler versus furrow irrigation fields for the first six weeks of the 2023 harvest season. Gross revenues were estimated and calculated using a Spreckels Sugar Revenue Calculator utilizing a $0.37/pound net selling price for sugar.

Table 1: Comparison of sprinkler versus furrow irrigated fields planted in September 2022 and harvested during the first six weeks of the 2023 harvest.

Week Ending	Sprinkler/Furrow	Acres	Emergence	ESA	Rev/Acre
4/17/23	Sprinkler	310	70.2	10,617	$2,390
4/17/23	Furrow	43	41.9	10,201	$2,303
4/24/23	Sprinkler	504	70.1	11,987	$2,699
4/24/23	Furrow	139	51.3	11,069	$2,500
5/1/23	Sprinkler	378	66.2	12,274	$2,770
5/1/23	Furrow	192	48.9	11,558	$2,609
5/8/23	Sprinkler	390	68.4	13,425	$3,022
5/8/23	Furrow	523	57.7	12,000	$2,704
5/15/23	Sprinkler	425	68.0	13,760	$3,099
5/15/23	Furrow	278	53.1	11,967	$2,694
5/22/23	Sprinkler	164	65.1	13,296	$2,994
5/22/23	Furrow	45	56.4	11,981	$2,688

Figure 2 shows the advantage of sprinkler versus furrow irrigated fields for extractable sucrose per acre for each of the six weeks. In all six weeks of data, the sprinkler irrigated fields out yielded the furrow irrigated fields for extractable sucrose per acre. The average advantage for the sprinkler irrigated fields was 1,097 pounds of extractable sucrose per acre over these six weeks.

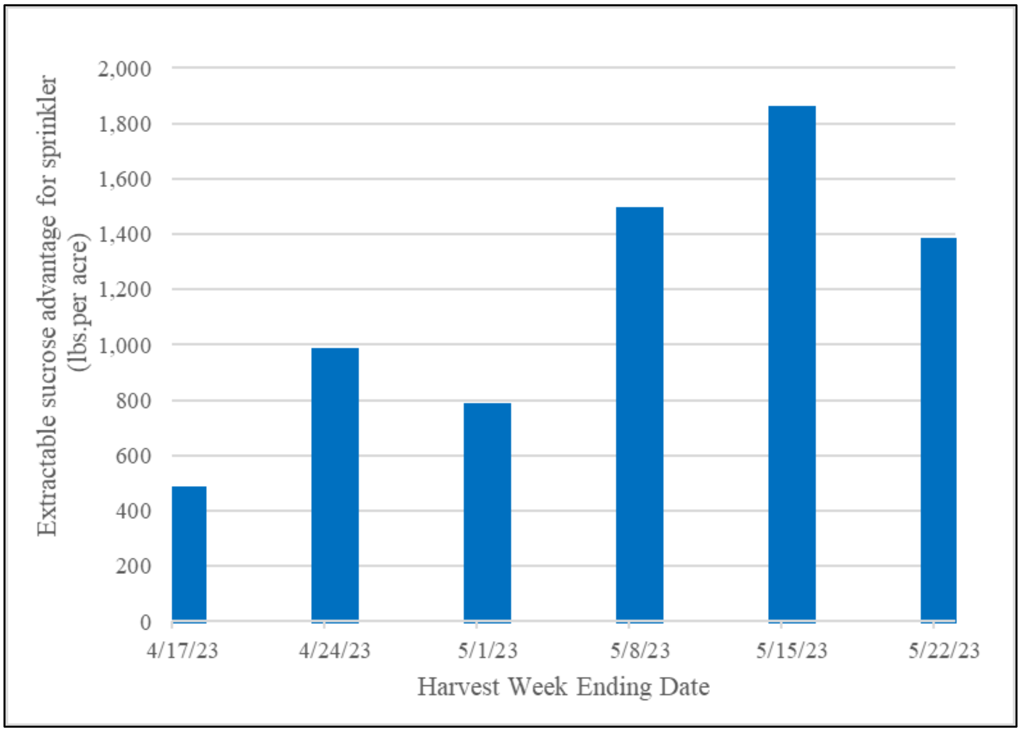

Figure 2: Extractable sucrose per acre advantage of sprinkler irrigated fields versus furrow irrigated fields from the first six weeks of the 2023 harvest season.

Figure 3 shows the gross revenue per acre advantage of sprinkler irrigated fields over furrow irrigated fields over the first six weeks of harvest. The revenue per acre difference shown is a gross revenue per acre value and does not include any costs associated with either type of irrigation system. Figure 3 illustrates that in all six weeks of the project, sprinkler irrigated fields had greater revenue per acre than the furrow irrigated fields. This revenue advantage averaged $246 per acre over the six weeks.

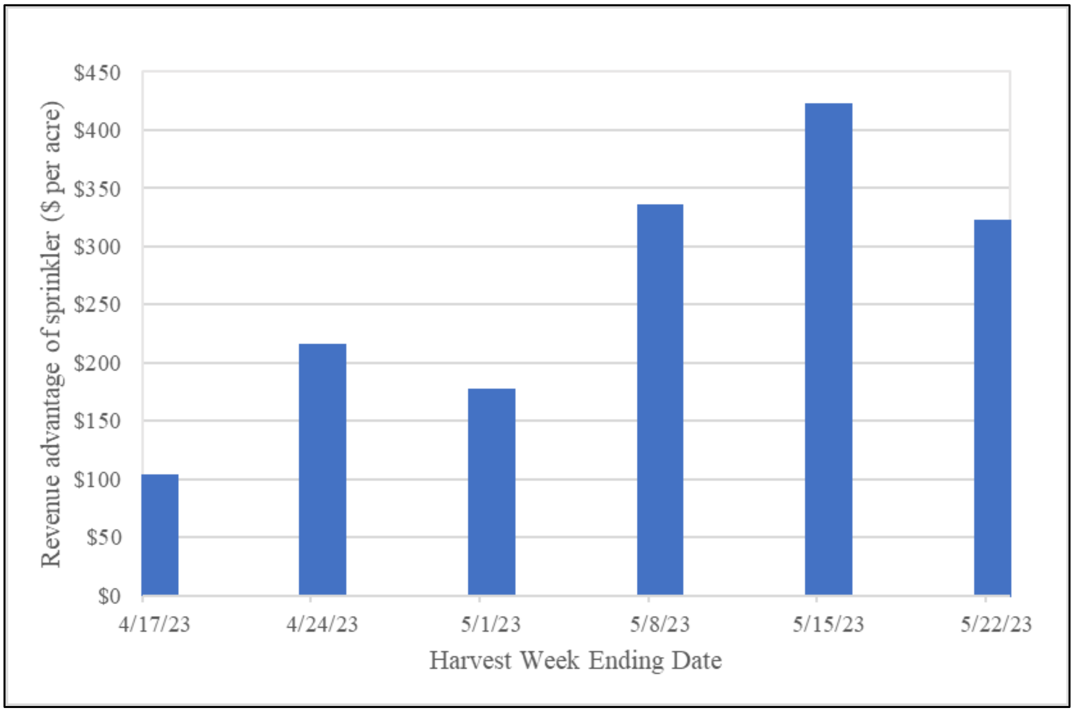

Figure 3: Revenue per acre advantage of sprinkler irrigated fields versus furrow irrigated fields from the first six weeks of the 2023 harvest season.

The 2022-2023 data shown in this report is the third year of data from this project. This project was also conducted in the 2020-2021 and 2021-2022 growing seasons. In the 2020-2021 season, sprinkler irrigated fields yielded 1,119 lbs. of extractable sucrose per acre and $222 per acre greater than furrow irrigated fields over a seven-week harvest period. In the 2021-2022 season, sprinkler irrigated fields yielded 499 lbs. of extractable sucrose per acre and $100 per acre greater than furrow irrigated fields over a five-week harvest period. The 2020-2021 and 2021-2022 season results can be viewed in the 2020-2021 and 2021-2022 Spreckels Sugar Research Reports (http://www.spreckelssugar.com/Agronomy/Research.aspx).

In addition to the field project, a research trial comparing sprinkler versus furrow irrigation was conducted for the 2021-2022 and 2022-2023 growing seasons and is being repeated for the 2023-2024 growing season.

This irrigation project would not have been possible without the efforts of the Spreckels Sugar Agriculturists collecting the field information and stand counts on the fields during the fall of 2022. Thank you to Leslie Gutierrez, Serenity Dockstader McCallum, and Jeremy Scheffler for collecting the field data. Thank you to Sergio Bastidas for providing the weekly yield data and Dimitri Boratynski for organizing and prioritizing this project.

SPRECKELS Research

2022-2023 Sugar Beet Emergence Utilizing Furrow and Sprinkler Irrigation – Research Trial

Mark Bloomquist[1], Joaquin Santiago[1], and John Lamb[2]
Spreckels Sugar Company Inc[1]., University of Minnesota[2]

Justification:

The Imperial Valley climate can be very harsh for the emergence of seedling sugar beet plants. The daily high temperatures in September are often in excess of 100 degrees F. In addition to these temperatures, many of the soils in the Imperial Valley have salt levels that can create emergence issues for small-seeded crops. Traditionally, sugar beet is furrow irrigated in the Imperial Valley. However, there has been increasing interest in utilizing solid set sprinkler pipe during the germination and emergence period and then converting the field to furrow irrigation once the sugar beet stand is established. This project was developed to quantify if there are sugar beet emergence differences between these two irrigation methods. If differences exist, do these differences equate to a root yield and quality difference at harvest?

Objective:

The objective of this project is to determine if an advantage exists to sprinkler irrigation versus furrow irrigation during the germination and emergence period. Comparisons will include emergence percent, root yield, and quality. The project consists of a replicated research trial conducted at the Imperial Valley Research Center in Brawley, CA. The trial compared the use of sprinkler irrigation to furrow irrigation during the emergence period. Two varieties were utilized to compare variety responses to the two irrigation types.

Material and Methods:

In the fall of 2022, a research trial was initiated at the Imperial Valley Research Center, Brawley, CA. The trial was conducted as a randomized complete block in a split-plot arrangement with three replications. Irrigation type (sprinkler, furrow) was the whole plot, and variety was the subplot. The two varieties utilized in the trial were BTS 5678 and SV 983. The irrigation strips were set up as 12-row strips with 12 rows of unplanted area between the strips. The unplanted area separated the irrigation treatments to prevent water from the sprinkler treatments from reaching the adjacent strip. Figure 1 is a map of the trial.

Prior to listing beds, 100 pounds per acre of MAP fertilizer (11-52-0) was applied to the trial area. Nitrate nitrogen soil test results to a four-foot depth showed 170 pounds of nitrogen per acre. Once beds were listed, 106 pounds of nitrogen per acre was injected into the bed as urea ammonium nitrate liquid fertilizer (32-0-0). The beds were shaped, and the trial was planted on September 15, 2022, at a 3" seed spacing. Following planting, irrigation basins were constructed on the furrow irrigation strips, and sprinkler pipe was installed in the sprinkler irrigation strips. Table 1 shows the dates irrigation treatments were applied. The sprinkler treatment utilized 5/64" nozzles and 40 psi. The furrow irrigation was applied with a 1.25" siphon tube in each row. The furrow treatment applied a total of 9.45" of irrigation water per acre, and 4.57" of water per acre was applied by the sprinkler treatment. The sprinkler treatment applied about half the amount of the water used in the furrow emergence treatment.

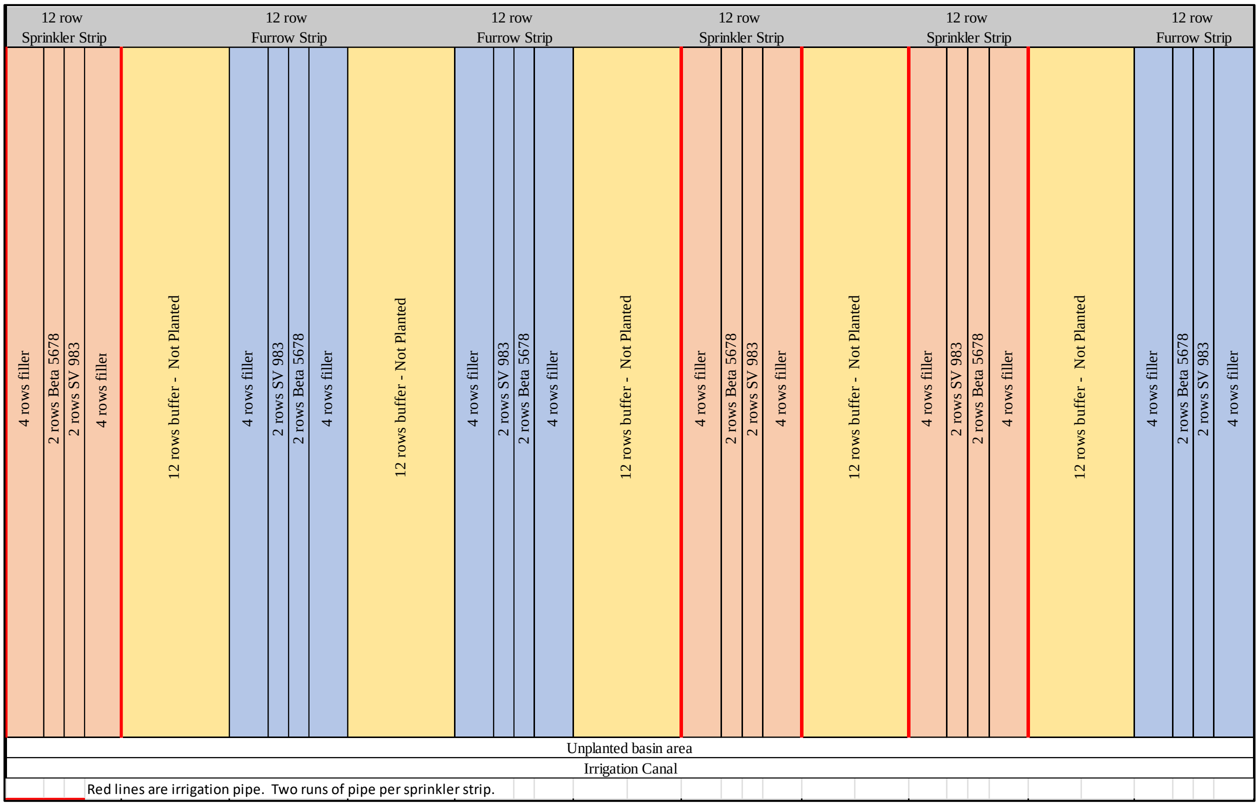

Figure 1. Trial map of 2022-2023 Irrigation Trial.

Table 1. Emergence irrigation treatments.

Irrigation Treatment	Date	Hours of Water Application
Sprinkler	September 16, 2022	20 hours
Sprinkler	September 19, 2022	12 hours
Sprinkler	September 21, 2022	12 hours
Furrow	September 16, 2022	5 hours
Furrow	September 22, 2022	2 hours

Emergence stand counts were taken on September 27. Stand counts were taken for both varieties on each subplot by counting all the emerged beets per range. This provided ten stand counts per variety per replicate. For the analysis, stand counts were converted to sugar beet plants per 100 feet of row. Crop protection products were applied to the trial on an as-needed basis during the growing season. After the initial irrigation treatments, the entire trial was converted to furrow irrigation, and all treatments received the same irrigation practices and amounts of water for the remainder of the season.

The trial was harvested on April 27, 2023. Root yield was collected in each variety and each irrigation treatment with a two-row research harvester. Plot weights were recorded on the harvester, and a sub-sample of the beets was obtained for quality analysis at the Spreckels Sugar Tare Lab. The trial was analyzed as an RCBD in a split-plot arrangement with sampling. The analysis was conducted utilizing Proc Mixed in SAS 9.4. Treatment differences were considered significant at a 0.1 significance level.

Results and Discussion:

Table 2 contains the results of the statistical analysis. An interaction occurred with the emergence percent, sugar beet stand, root yield, and extractable sucrose per acre. The interactions on the emergence percent and sugar beet stand appear to be caused by different variety responses to the irrigation treatments. Figure 2 and Figure 3 contain the emergence and sugar beet stand counts for all four treatments. The SV 983 shows less advantage to sprinkler irrigation than the BTS 5678. Figure 4 contains the root yield for the four treatments, and Figure 5 contains the extractable sucrose per acre. For the root yield and extractable sucrose per acre, SV 983 with sprinkler irrigation was numerically greater than with furrow irrigation. For BTS 5678 root yield and extractable sucrose per acre, furrow irrigation was numerically greater than sprinkler irrigation.

Table 2. Statistical analysis of the 2022-2023 trial.

Term	Emergence	Beet Stand	Root Yield	Sucrose %	ESA
Irrigation Type	0.247	0.249	0.5868	0.48	0.484
Variety	<0.0001	<0.0001	0.247	0.008	0.85
I x V	0.0179	0.0181	0.0019	0.34	0.009

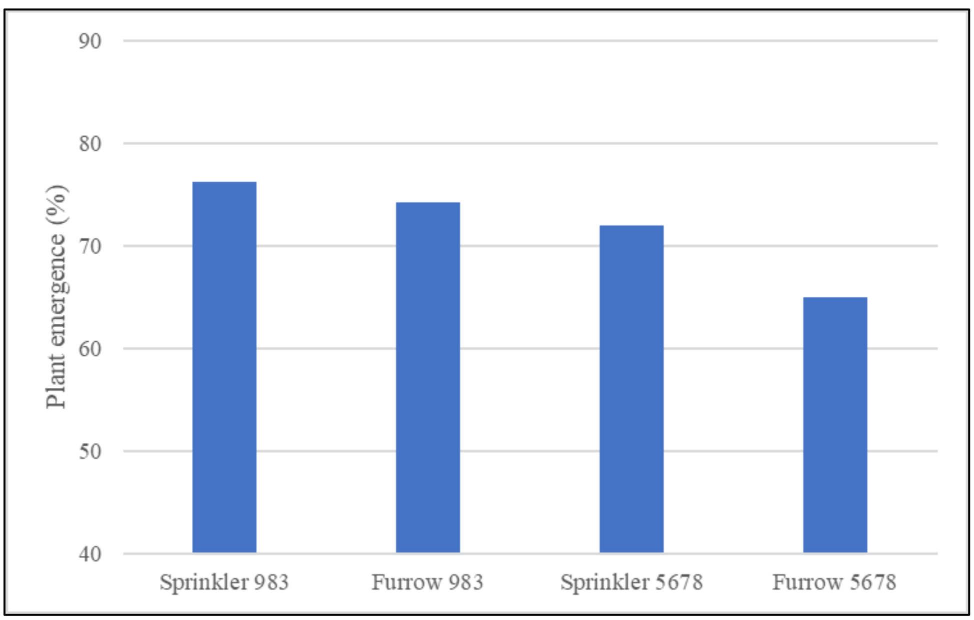

Figure 2. Emergence percent of SV983 and BTS 5678 for both the sprinkler and furrow treatments.

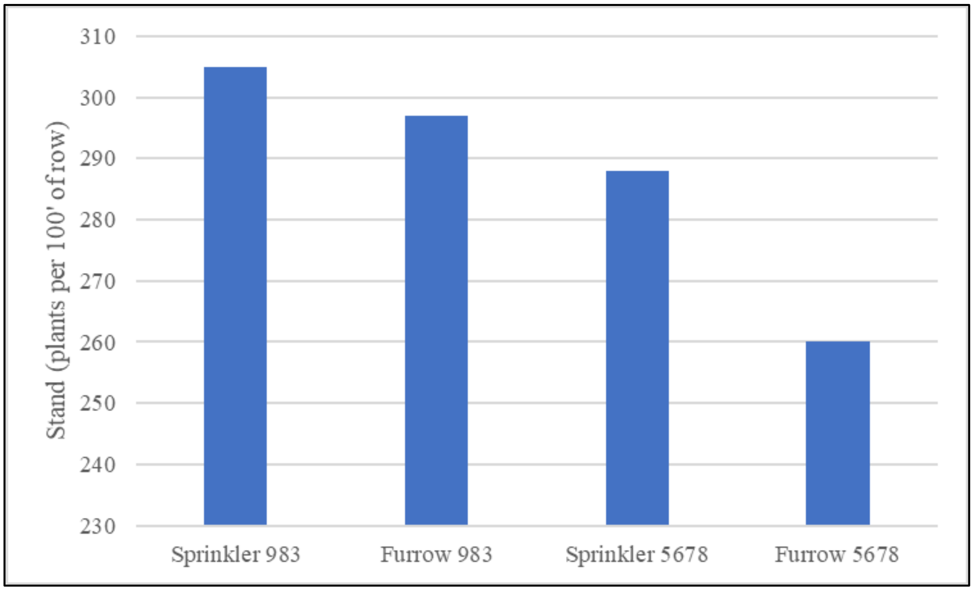

Figure 3. Sugar beet stand counts per 100' of row of SV983 and BTS 5678 for both the sprinkler and furrow treatments.

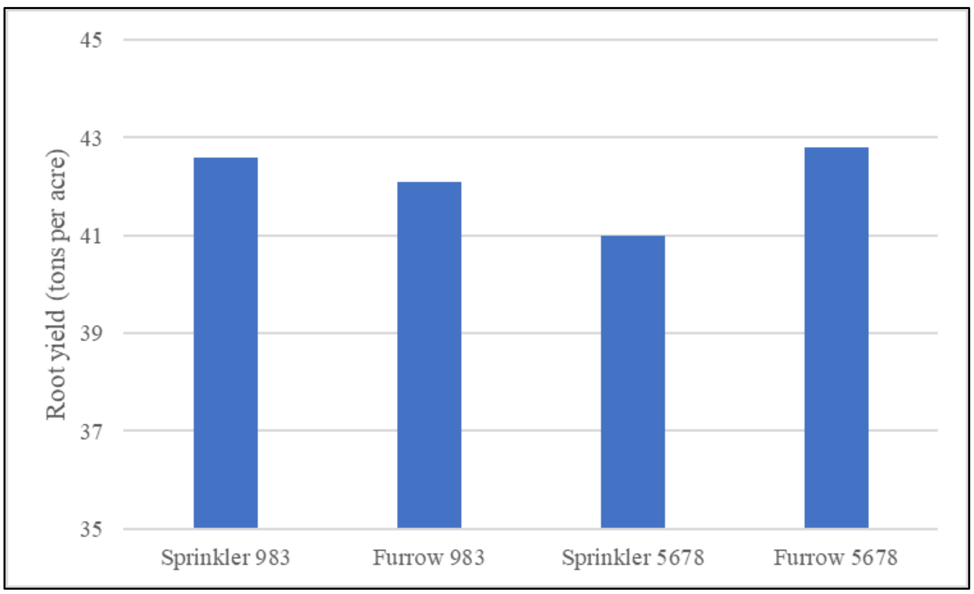

Figure 4. Sugar beet root yield for SV 983 and BTS 5678 for both the sprinkler and furrow treatments.

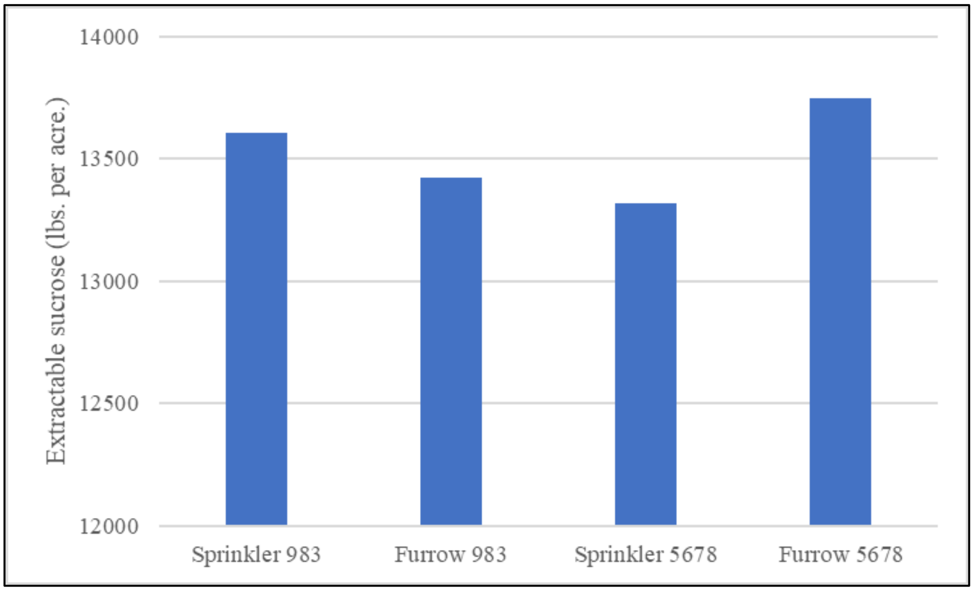

Figure 5. Extractable sucrose per acre for SV 983 and BTS 5678 for both sprinkler and furrow treatments.

The emergence and yield results from the 2022-2023 trial show a reduced benefit to sprinkler irrigation than the 2021-2022 results. The 2021-2022 trial results can be found in the 2021-2022 Spreckels Sugar Research Report: https://www.spreckelssugar.com/Agronomy/Research/2021-2022%20Spreckels%20Sugar%20Research%20Report.pdf. One possible reason for the difference is the temperature patterns from September 2021 versus September 2022. Figure 6 shows the daily high temperatures for Imperial, CA, from September 13 – September 24 for both years. The high temperatures were considerably greater on most days during 2021 compared to 2022. This likely caused additional stress on the emerging sugar beets under the furrow irrigation system.

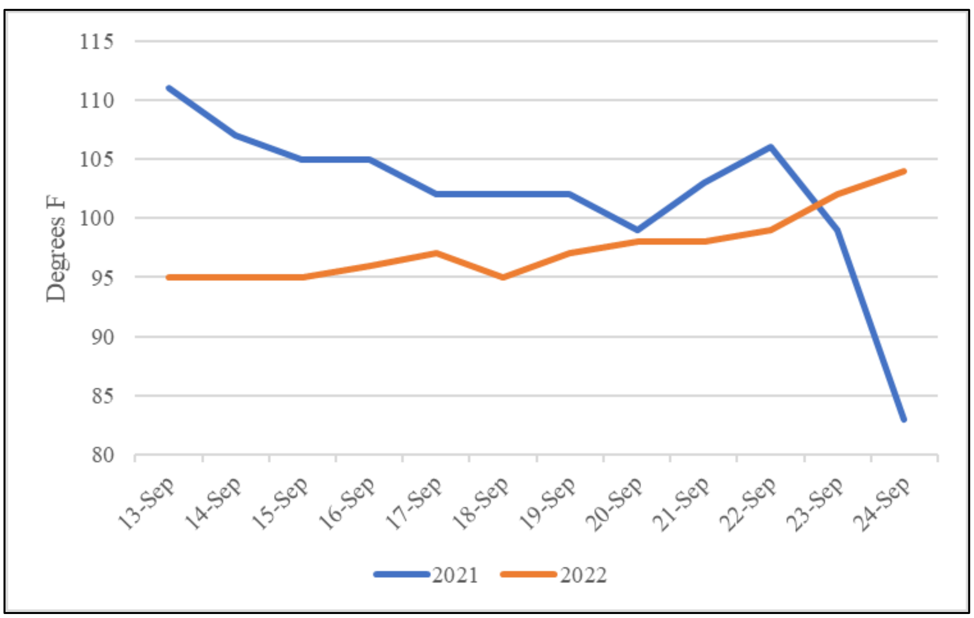

Figure 6. Daily high temperatures for Imperial, CA, for September 2021 and September 2022. https://www.wunderground.com/history

Conclusions:

In the first season of this early season irrigation trial, sugar beet emergence, sugar beet stand, and extractable sucrose per acre were increased by sprinkler irrigation compared to furrow irrigation during the germination and emergence period. The results from the second season of the trial did not show as large of an advantage to sprinkler irrigation for sugar beet emergence and stand. The root yield results from season two of the trial did not show an advantage to the sprinkler system. The temperature pattern during mid-September between the two seasons may be responsible for the different results. This trial is being repeated at the Imperial Valley Research Center for the 2023-2024 growing season.

SPRECKELS
Research

2022-2023 Late Season Irrigation Trial

Mark Bloomquist[1], Joaquin Santiago[1], and John Lamb[2]
Spreckels Sugar Company Inc[1]., University of Minnesota[2]

Justification:

Sugar beet harvest in the Imperial Valley of California typically begins around April 1 and continues until approximately August 1 each season. During the final 4-6 weeks of the harvest season, daily temperatures in the Imperial Valley often exceed 110 degrees Fahrenheit. This extreme heat, in combination with anaerobic soil conditions that can occur with furrow irrigation water applications, creates an environment favorable for “late rot” to develop in the sugar beet roots. Phytophthora and Pythium root rot are two root diseases that can develop under these conditions (Kaffka et al., 2009). Because multiple organisms can cause late rot, the disease will be referred to as late rot complex in this report. Rot developing in the sugar beet during the late harvest season decreases the crop's sucrose content, purity, and root yield potential. In severe infestations of late rot, fields must be rogued to remove rot-infested sugar beet roots or abandoned (Dimitri Boratynski personal communication). Preliminary field observations by Imperial Valley growers suggest that sprinkler irrigation late in the growing season may reduce late rot development in fields compared to furrow irrigated fields. This research trial was developed to investigate the effect of variety tolerance to late rot using sprinkler and furrow irrigation in a controlled experiment.

Objective:

Determine the effect of variety tolerance with sprinkler and furrow irrigation on late rot development, root yield, and root quality during the July to August harvest period.

Material and Methods:

In the fall of 2022, a research trial was initiated at the Imperial Valley Research Center, Brawley, CA. The trial was conducted as a randomized complete block in a split-plot arrangement with three replications. Irrigation type (sprinkler, furrow) was the whole plot, and variety was the subplot. The two varieties utilized in the trial were a late rot tolerant variety (BTS 5460) and a late rot susceptible variety (SV 501). The irrigation strips were set up as 12-row strips with 12 rows of unplanted area between the irrigation treatments. The unplanted area separated the irrigation treatments to prevent water from the sprinkler treatments from reaching the adjacent strip. Figure 1 is a map of the trial site.

Prior to listing beds, 100 pounds per acre of MAP fertilizer (11-52-0) was applied to the trial area. The soil test residual nitrogen was 150 pounds per acre to a four-foot depth. Once beds were listed, 140 pounds of nitrogen per acre was injected into the bed as urea ammonium nitrate liquid fertilizer (32-0-0). On December 6, 2022, an additional 70 pounds of nitrogen were applied as UAN 32 as a layby application. The beds were shaped, and the trial was planted on October 5, 2022, at a 3” seed spacing. Following planting, sprinkler irrigation was applied to the entire trial for germination and emergence.

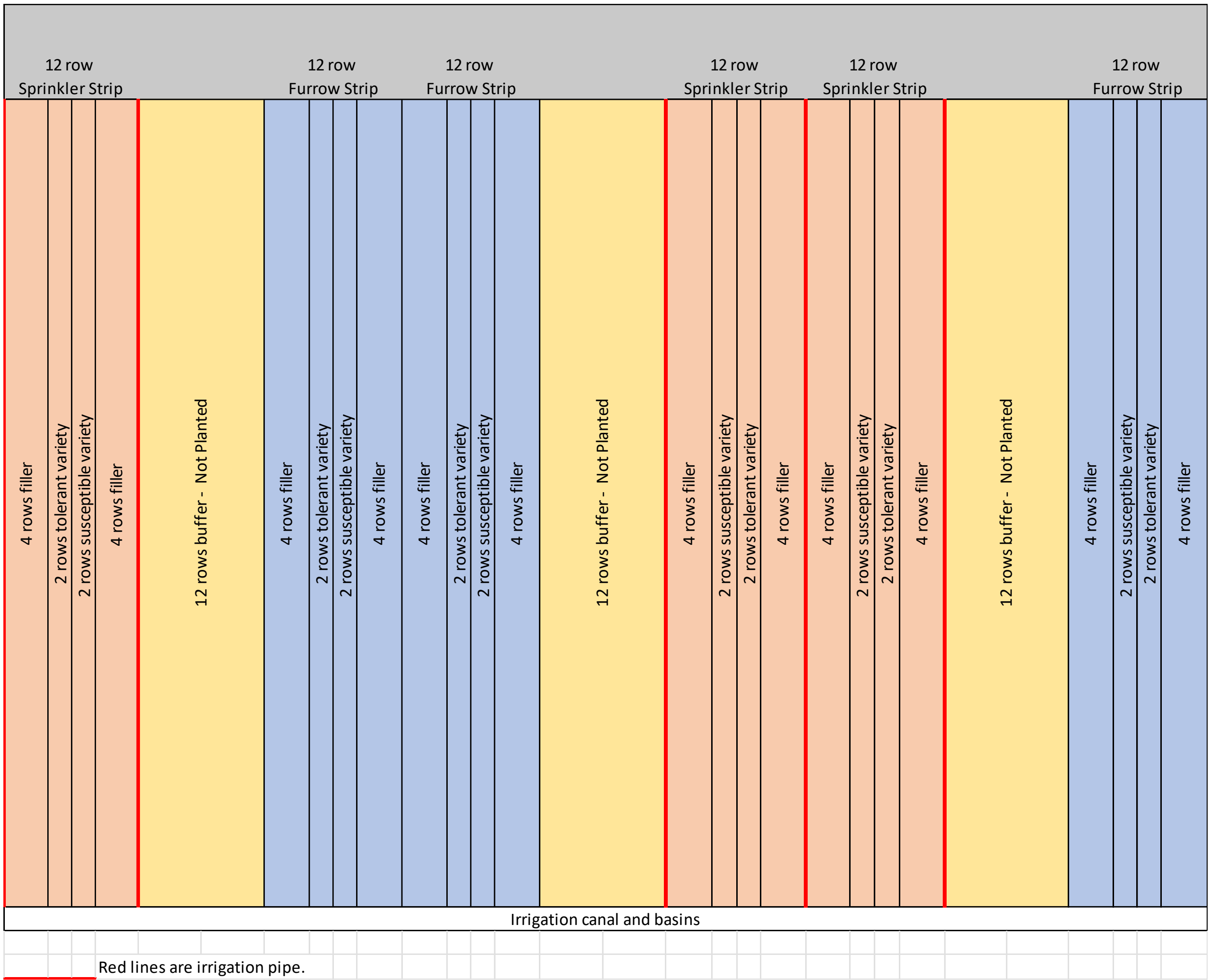

Figure 1. Trial map of 2022-2023 Late Season Irrigation Trial.

Following emergence, subplots were established in each variety and irrigation type. The subplots were 30 feet long, minus a four-foot alley. These subplots were used for final stand counts, rot counts, harvest yield, and quality. Final stand counts were taken on October 31 for both varieties on each subplot by counting all the beets per plot. This provided ten stand counts per variety per replicate. On October 26, the trial was converted to furrow irrigation, and the irrigation water was applied to every other furrow until the irrigation treatments were installed at the end of May. Crop protection products were applied to the trial on an as-needed basis during the growing season for weed, insect, and foliar disease management.

The irrigation treatments were installed in late May, and the first sprinkler versus furrow irrigation treatments were applied on May 24 and 25. Furrow irrigation was conducted with a 1.25” siphon on every other row for the first two irrigations. Then double siphons were used every other row for the final three irrigations. Sprinkler irrigation was conducted with a 5/64” sprinkler nozzle and 45 psi. The hours of operation were tracked to calculate the amount of water applied with each irrigation treatment. Table 1 contains the dates and hours of irrigation for the two irrigation treatments.

Table 1. Irrigation dates and hours of operation for the sprinkler and furrow irrigation treatments.

Sprinkler Treatment		Furrow Treatment		
Date	Hours	Date	Hours	
24-May	12	25-May	8	
12-Jun	12	13-Jun	8	
26-Jun	12	29-Jun	4	double siphons
6-Jul	12	13-Jul	4	double siphons
13-Jul	12	28-Jul	4	double siphons
20-Jul	12			
28-Jul	12			
4-Aug	4			

Total water use was calculated based on hours of operation for each irrigation type and an application rate of 0.127" per hour for sprinkler irrigation and 0.685" per hour for furrow irrigation. The total water applied through the sprinklers was 11.2 inches, and for the furrow treatment, the total application was 27.4".

Rot counts were taken across the trial on July 24, August 1, 8, and 14. The rot counts included counting all the beets with visual above ground rot symptoms in each subplot. The number of rot beets was divided by the final stand of each subplot to determine the percentage of rot for each subplot.

The trial was defoliated on August 14, and all beets with visual rot symptoms were rouged out of the row before harvest. The rouging of the rotten beets out of the row follows the harvest practice that growers must do when late rot reaches a critical level in their field. Removing the rotten beets from the row provides a harvest root yield and quality based on good-quality sugar beets. Harvest was conducted on August 15, 2023. Root yield was collected in each variety and each irrigation treatment with a two-row research harvester. Plot weights were recorded on the harvester, and a sub-sample of the beets was obtained for quality analysis at the Spreckels Sugar Tare lab.

Extractable sucrose per acre was calculated for each subplot, as well as gross revenue per acre. Gross revenue per acre was calculated using a Spreckels Sugar revenue calculator with a $37 per hundred weight net selling price of sugar. The trial was analyzed as an RCBD in a split-plot arrangement with sampling. The analysis was conducted utilizing Proc Mixed in SAS 9.4. Treatment differences were considered significant at a 0.1 significance level.

Results:

Rot counts were taken in the weeks prior to harvest of the trial. These rot counts were converted to a percentage of rot and are shown in Figure 2. The percentage of rot increased in all four treatments. However, the tolerant variety with sprinkler irrigation remained the lowest of all the treatments at 5.3% rot on August 14. The susceptible variety with furrow irrigation had the highest percentage of rot at 27.2% on August 14. The combination of the tolerant variety with sprinkler irrigation provided the best suppression of late rot of the four treatments in the trial.

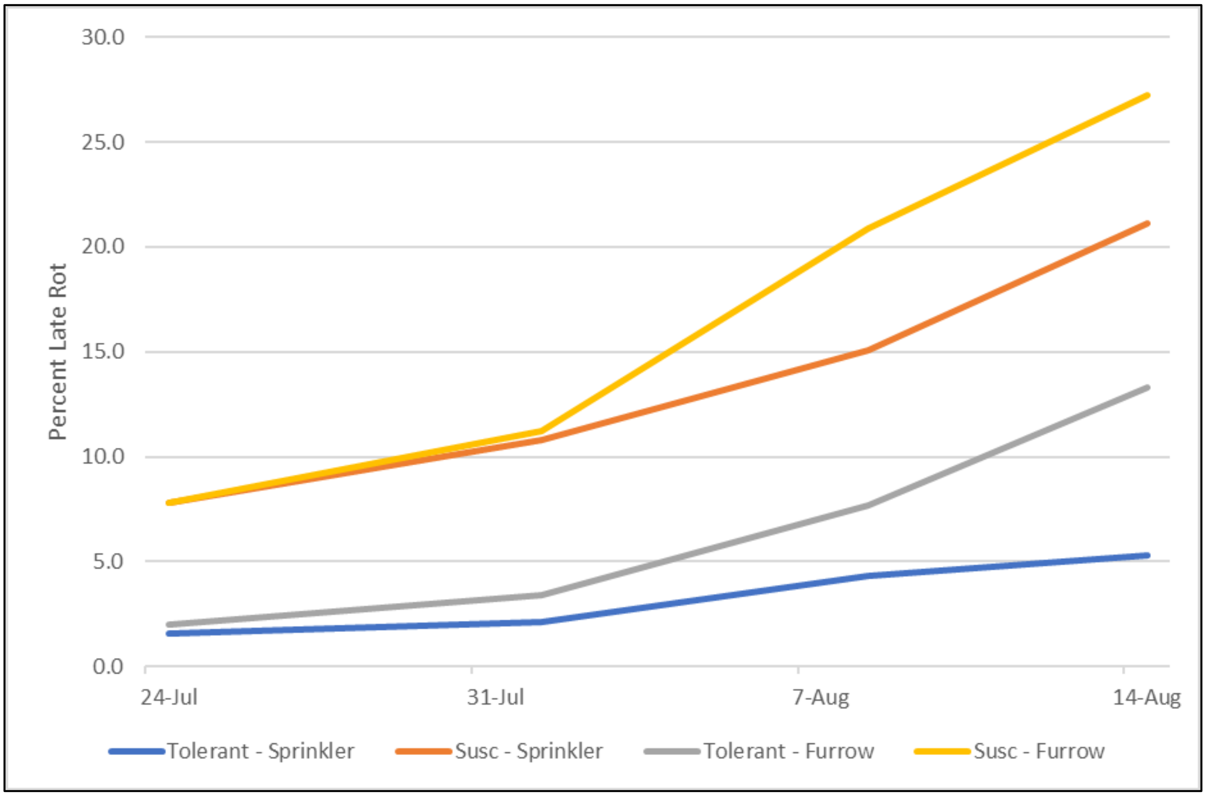

Figure 2. Percent rot of the treatments between July 24 and August 14.

The root yield, quality, and gross revenue results were tabulated for irrigation type, variety, and variety by irrigation type. Table 2 contains the root yield, quality, and gross revenue results by irrigation type. Sucrose content was statistically greater with sprinkler irrigation versus furrow irrigation. Root yield, ESA, and gross revenue per acre were numerically greater for sprinkler irrigation but not statistically significant. This could be caused by the number of replications being only three for the trial. The study will be conducted over additional years to increase the precision of the evaluation of the irrigation system.

Root yield, quality, and gross revenue results by variety are shown in Table 3. The late rot tolerant variety had statistically greater root yield, extractable sucrose per acre, and gross revenue per acre compared to the susceptible variety. In Figure 2, the rot percentage was considerably greater in the susceptible variety, leading to a decrease in root yield for the susceptible variety. The susceptible variety did, however, have statistically greater sucrose content than the tolerant variety. This difference in sucrose content is likely caused by the susceptible variety being genetically greater in sucrose content and the rot beets being rogued out of the row, preventing low-quality rot-infected beets from being harvested. The differences in root yield are greater by variety than by irrigation type; this difference in root yield was enough to be statistically significant by variety. Table 4 contains the root yield, quality, and gross revenue information for each variety by irrigation treatment.

Table 2. Yield results by irrigation type.

Irrigation Type	Root yield (tons/acre)	Sucrose %	Purity %	ESA (lbs./A)	Rev/Acre ($/A)
Sprinkler	53.2	15.6a	85.8	12,943	$2,890
Furrow	51.6	14.7b	86.0	11,636	$2,601
Pr>F	0.785	0.044	0.869	0.49	0.50
alpha	0.1	0.1	0.1	0.1	0.1
Reps	3	3	3	3	3

Table 3. Yield results by variety.

Variety	Root yield (tons/acre)	Sucrose %	Purity %	ESA (lbs./A)	Rev/Acre ($/A)
Tolerant Variety (BTS 5460)	59.4a	14.9b	85.7	13,767a	$3,075a
Susceptible Variety (SV 501)	45.3b	15.4a	86.0	10,811b	$2,416b
Pr>F	<0.0001	<0.0001	0.30	<0.0001	<0.0001
Alpha	0.1	0.1	0.1	0.1	0.1
Reps	3	3	3	3	3

Table 4. Yield results by irrigation type and variety.

Irrigation Type	Variety	Root yield (tons/acre)	Sucrose %	Purity %	ESA (lbs./A)	Rev/Acre ($/A)
Sprinkler	Tolerant	60.6	15.4	85.7	14,566	$3,253
Sprinkler	Susceptible	45.8	15.9	85.8	11,319	$2,528
Furrow	Tolerant	58.3	14.3	85.7	12,969	$2,898
Furrow	Susceptible	44.9	15.0	86.2	10,303	$2,304

Conclusions:

The late rot tolerance of certain varieties has been established through the Official Variety Trials and grower field information in the past, and this trial supports that data for variety tolerance. Tolerant varieties are very important for successful sugar beet production on fields harvested in July and August. In the 2022-2023 trial, sprinkler irrigation was numerically better than furrow irrigation for rot development and yield. Additional trials are planned to continue to explore the potential advantage of sprinkler irrigation for late-harvest fields. Spreckels Research is repeating this trial at the Imperial Valley Research Center for the 2023-2024 growing season.

SPRECKELS Research

Nitrogen Rate Effect on Sugar Beet Varieties Grown in the Imperial Valley of California, 2022 – 2023 Growing Season

John A. Lamb[1] and Mark W. Bloomquist[2]
[1]Professor and Nutrient Management Extension Specialist (emeritus), University of Minnesota, St. Paul, Minnesota, [2]Research Director, Southern Minnesota Beet Sugar Cooperative, Renville, Minnesota

Growers in the Imperial Valley have adopted glyphosate resistant varieties in their sugar beet production system. Nitrogen application is one of the most important factors in producing good quality sugar beet. Many new varieties have been developed with the glyphosate resistant genetics and little is known about the varieties response in tonnage and quality to N fertilizer application rates. Kaffka 2007 reported that the optimum N application rate for sugar beets harvested in June and July was 220 lb N/A with another 100 lb nitrate-N/A in the surface 43 inches of soil at planting. A number of research reports found on the Spreckels Sugar website (www.spreckelsugar.com) Research Reports tab report on recent field research on N application in the Imperial Valley. The research by Lamb, Santiago, and Bloomquist, resulted in varied responses from the use of N fertilizer in the Imperial Valley from 2013 to 2018. New information is needed because of the introduction of glyphosate resistant varieties and the increased production capacity of these new varieties.

Research Objective

- Determine the effect of nitrogen rate on sugar beet varieties.

Methodology

An experiment was established at the Imperial Valley Research Center (IVRC22) in the fall of 2022. The treatments were the factorial combination of eight nitrogen application rates (0, 40, 80, 120, 160, 200, 240, and 280 lb N/A) and two sugar beet varieties. These varieties were chosen using the results from the Official Variety Trials (OVT) conducted in the Imperial Valley. The varieties were a top tonnage variety (Beta 5678) and a top-quality variety (SV 983). Two additional varieties included in an incomplete factorial design (Beta 5460 and SV 2997N). These varieties were chosen based on popularity in the case of Beta 5460 and new genetics in the case of SV 2997N. The N application rates for the additional varieties were 0 and 200 lb N/A. The soil test values for IVRC 22 are listed in Table 1. The soil nitrate-N to a depth of four feet was 88 lb N/A. A pre-plant application of phosphate fertilizer (11-52-0 MAP) was applied to all plots. This supplied 11 lb N/A. With the preplant MAP application at IVRC22, the total N available for the crop was 99 lb N/A. The nitrogen source for the treatments was liquid UAN (32-0-0). The N fertilizer treatments were applied pre-plant. The treatments for this study are in Table 2. The study had four replications. The IVRC22 site was planted October 6, 2022. Petioles from the most recently matured leaves were be sampled February 21, 2023, at IVRC22 to determine the effect of the treatments on the nitrogen status of the sugar beet plants. The roots were harvested May 18, 2023. Root quality was determined by the Spreckels Sugar quality laboratory.

Table 1. Soil test values for IVRC22 in fall 2022.

Soil test	IVRC 22
Nitrate-N (0-4 ft.) lb N/A	88
Olsen P (0-1 ft.) ppm	15
K (0-1 ft.) ppm	413

Table 2. Treatments for the nitrogen rate and application time study.

Treatment number	N rate	Variety
1	0	Beta 5678
2	40	Beta 5678
3	80	Beta 5678
4	120	Beta 5678
5	160	Beta 5678
6	200	Beta 5678
7	240	Beta 5678
8	280	Beta 5678
9	0	SV 983
10	40	SV 983
11	80	SV 983
12	120	SV 983
13	160	SV 983
14	200	SV 983
15	240	SV 983
16	280	SV 983
17	0	Beta 5460
18	200	Beta 5460
19	0	SV 2997N
20	200	SV 2997N

Results and Discussion:

IVRC22 2022 – 2023:

Sugar beet yield was quite good for the early harvest date of May 18, 2023. The quality was considerably less than normal and when compared to growers' production fields in the Imperial Valley of California.

N rate for Beta 5678 and SV 983

The statistical analysis for root yield, extractable sucrose per T, extractable sucrose per A, purity, and petiole nitrate-N is presented in Table 3. Root yield was significantly affected by variety. SV 983 produced a greater tonnage than Beta 5678, Table 4. The advantage was three ton per A. Nitrogen rate did not affect the root yield for either variety at IVRC22.

Petiole nitrate-N values from samples taken on March 1 were not affected by variety or N rate nor was extractable sucrose per A at harvest.

Extractable sucrose per T, Table 4 and Figure 1, and purity, Table 5 and Figure 2, were affected by an interaction with variety and N rate. For both extractable sucrose per T and purity, Beta 5678 was not affected by N rate, while SV 983 had increased extractable sucrose per T and purity as N rate was increased.

Extractable sucrose per A was not significantly affected by variety or N rate in 2022-2023, Table 3 and Table 4.

In summary, the use of N fertilizer did not affect sugar beet root yield and extractable per A while the use of N fertilizer did increase sugar beet quality parameters for SV 983 and not Beta 5678. There is no reason why the quality was increased in SV 983 with increasing N rate. Normally the quality is reduced when excess N is applied to a sugar beet crop.

Table 3. Statistical analysis of N rate for Beta 5678 and SV 983 for root yield, extractable sucrose per T, extractable sucrose per A, purity, and petiole nitrate-N at IVRC22 grown in the 2022 - 2023 growing season.

		Extractable sucrose		Purity	Petiole nitrate-N
Term	Root yield	lb/T	lb/A	%	ppm
Rep	0.34	0.21	0.08	0.51	0.11
Variety	0.0002	0.0042	0.41	0.22	0.48
N rate	0.1106	0.0186	0.11	0.40	0.93
Variety X Nrate	0.1327	0.0168	0.16	0.04	0.14
C.V. (%)	4.5	4.3	5.9	1.9	46.7
Grand mean	63.7	231	14717	86.6	3057

Table 4. The means for N rate by Variety for Beta 5678 and SV 983 for root yield, extractable sucrose per T, and extractable sucrose per A at IVRC22 grown in 2022 – 2023 growing season.

	Root yield			Extractable sucrose					
N rate	Beta 5678	SV 983	Mean	Beta 5678	SV 983	Mean	Beta 5678	SV 983	Mean
lb N/A	T/A			lb/T			lb/A		
0	60.0	68.0	64.6	232	221	226	14080	15005	14609
40	65.1	67.7	66.4	235	219	227	15183	15124	15154
80	60.6	64.2	62.4	236	227	232	14331	14574	14452
120	64.2	63.6	63.9	241	213	227	15665	13981	14823
160	60.4	63.3	61.7	238	232	235	14413	14449	14428
200	62.0	65.4	63.8	230	223	226	14055	14581	14355
240	61.0	65.5	63.2	235	230	233	14318	14922	14577
280	63.8	63.5	63.6	235	254	243	14977	16086	15452
Mean	62.2	65.2		235	227		14611	14827	

Table 5. The means for N rate by Variety for Beta 5678 and SV 983 for purity, and petiole nitrate-N at IVRC22 grown in 2022 – 2023 growing season.

	Root purity			Petiole nitrate-N		
N rate	Beta 5678	SV 983	Mean	Beta 5678	SV 983	Mean
lb N/A	%			ppm		
0	86.7	86.3	86.5	2477	474	1680
40	87.5	85.8	86.6	1273	2524	2360
80	86.3	86.1	86.2	582	1599	1117
120	88.5	84.5	86.5	1024	1855	1415
160	87.5	85.9	86.7	1012	1792	1599
200	85.6	85.8	85.7	863	958	855
240	86.7	87.7	87.2	606	1557	1205
280	86.6	89.0	87.6	1726	1206	1461
Mean	86.9	86.4		1448	1487	

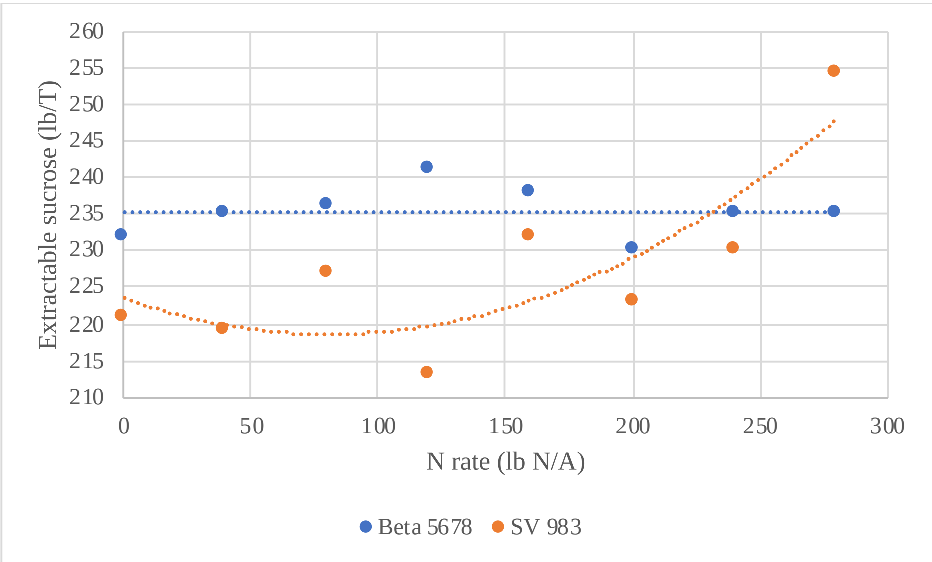

Figure 1. The interaction of variety and N rate on extractable sucrose per T at IVRC22.

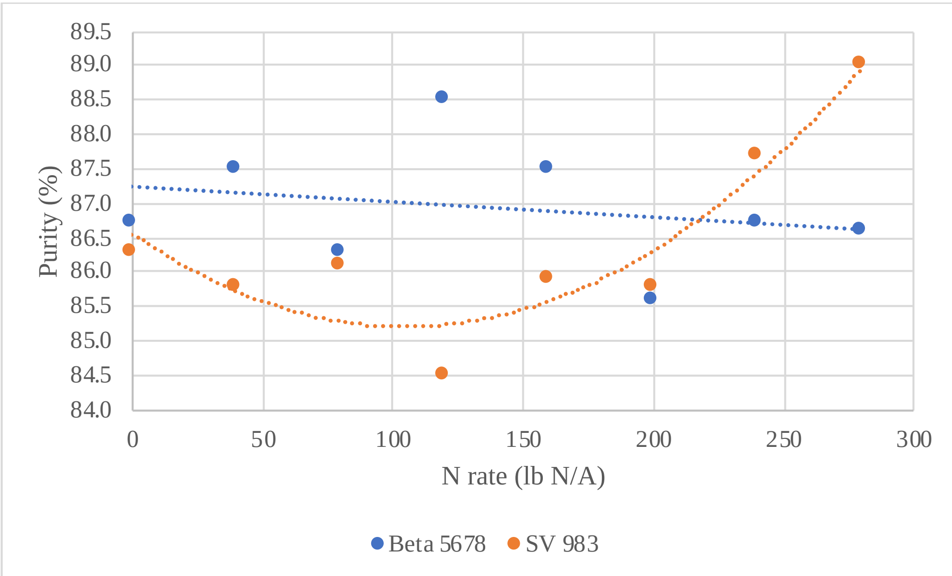

Figure 2. The interaction of variety and N rate on purity at IVRC22.

N response for Beta 5678, SV 983, Beta 5460, and SV 2997 at IVRC22

Four extra treatments were added to this study to be able to determine how other varieties would respond to N application compared to Beta 5678 and SV 983. Beta 5460 and SV2997N were added with N application rates of 0 and 200 lb N/A.

The statistically analysis comparing the four varieties at 0 and 200 lb N/A is listed in Table 6.

Root yield was affected by N rate, variety, and the interaction of N rate and variety, Table 6 and 7. The interaction, Figure 3., indicates that three of the four varieties root yield was increased by the addition of N. Only the root yield of SV 983 was decreased.

Extractable sucrose per T was only affected by variety, Table 6 and 7. SV 983 had the least extractable sucrose per T followed by SV 2997N and Beta 5678, with Beta 5460 producing the greatest extractable sucrose per T.

Extractable sucrose per A, Table 7, purity, Table 8, and petiole nitrate-N, Table 8, were not significantly affected by variety or N application, Table 6.

While root yield and extractable sucrose per T were affected by the treatments, overall the effect was not enough to change the extractable sucrose per A or root purity.

Table 6. Statistical analysis for response of Beta 5678, SV 983, Beta 5460, and SV 2997N to 200 lb N/A for root yield, extractable sucrose per T, extractable sucrose per A, purity, and petiole nitrate-N at IVRC22 grown in the 2022 - 2023 growing season.

		Extractable sucrose		Purity	Petiole nitrate-N
Term	Root yield	lb/T	lb/A	%	ppm
Rep	0.44	0.15	0.28	0.44	0.32
Variety	0.0001	0.03	0.64	0.25	0.74
N rate	0.08	0.15	0.12	0.89	0.73
Variety X Nrate	0.08	0.22	0.14	0.70	0.95
C.V. (%)	4.0	6.5	8.6	2.2	47.8
Grand mean	62.6	232	14623	86.6	2898

Table 7. The means for N rate by Variety for response of Beta 5678, SV 983, Beta 5460, and SV 2997N to 200 lb N/A for root yield, extractable sucrose per T, and extractable sucrose per A at IVRC22 grown in the 2022 - 2023 growing season.

	Root yield			Extractable sucrose					
	0 lb N/A	200 lb N/A	Mean	0 lb N/A	200 lb N/A	Mean	0 lb N/A	200 lb N/A	Mean
Variety	T/A			lb/T			lb/A		
Beta 5678	59.9	62.1	61.2	232	230	231	14080	14055	14067
SV 983	68.0	65.4	66.7	221	223	222	15005	14581	14793
Beta 5460	57.3	60.2	59.0	246	250	248	14626	14990	14869
SV 2997N	60.6	65.0	63.1	213	243	230	12529	15796	14707
Mean	62.0	63.2		228	237		14234	14909	

Table 8. The means for N rate by Variety for response of Beta 5678, SV 983, Beta 5460, and SV 2997N to 200 lb N/A for purity and petiole nitrate-N at IVRC22 grown in the 2022 - 2023 growing season.

	Root purity			Petiole nitrate-N		
	0 lb N/A	200 lb N/A	Mean	0 lb N/A	200 lb N/A	Mean
Variety	%			ppm		
Beta 5678	86.7	85.6	86.2	3587	3085	3336
SV 983	86.3	85.8	86.0	3006	2825	2915
Beta 5460	87.6	88.3	88.0	2793	2658	2726
SV 2997N	86.1	86.5	86.3	2547	2681	2915
Mean	86.6	86.6		2983	2812	

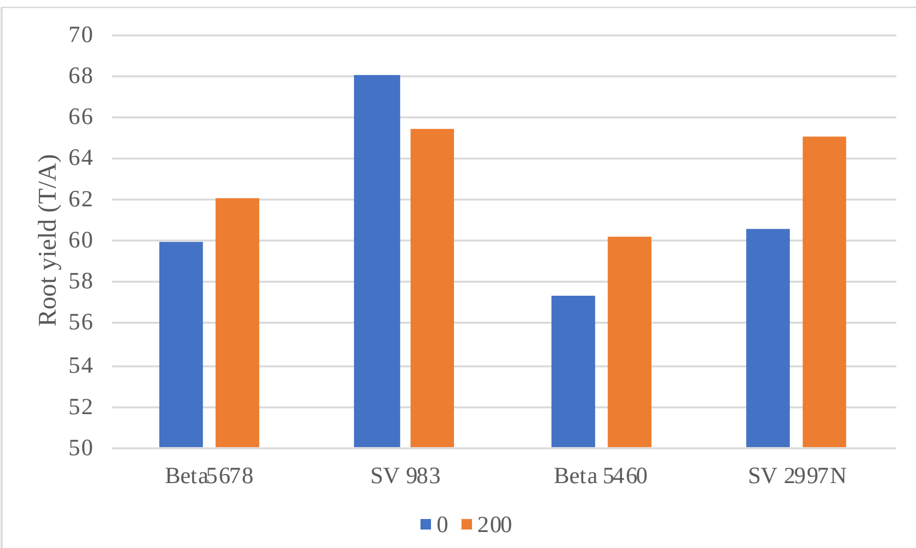

Figure 3. The interaction between variety and N rate for root yield at IVRC22.

Conclusions

The results for the IVRC22 location would not indicate that N application rate should not be adjusted for sugar beet variety. This is one year of a three-year study.

Literature Cited

Kaffka, S.R., 2007. Fertilizer N management for high-yielding sugar beets in California. Proceedings of IIRB Summer Congress, Marrakech, Morocco. Brussels, Belguim: International Institute for Beet Research.

Lamb, John, 2015. The Use of Slow Release Nitrogen Management for Sugar Beet Production in the Imperial Valley of California.

Lamb, John A. 2015. Nitrogen and Potassium Effects on Sugar Beet Quality .

Lamb, John A., Israel Santiago, and Mark Bloomquist. 2018. Nitrogen rate and timing study in Imperial Valley 2017-2018 growing season.

Santiago, Israel, Mark Bloomquist, and John Lamb. 2017. Nitrogen rate study conducted at Imperial Valley Research Center 2016 – 2017.

Summary of Nitrogen Fertilizer Rate Application in the Imperial Valley, 2012 to 2021.

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Abstract: A series of field experiments were conducted from the Fall of 2012 to Spring 2021 to evaluate fertilizer N application on sugar beet root yield, extractable sucrose per ton, and extractable sucrose per acre. Eighteen sites were planted, and sixteen sites were harvested. Soil nitrate-N was measured at each site to be used to help predict the optimum amount of N fertilizer to apply. Root yield was significantly affected by N application at nine of the 16 sites. Extractable sucrose per ton, a quality measurement, was affected by N application at 13 of the 16 sites, and extractable sucrose per acre, a combination of root yield and quality, was affected by N application at 7 of the 16 sites. The use of soil nitrate-N did not increase the prediction of how much fertilizer N to apply. Fertilizer N application is more important for sugar beet extractable sucrose per acre grown for early harvest than for sugar beet harvested late. Currently, the optimum N rate for extractable sucrose per acre for early harvest sugar beet is 231 lb N/A. For late harvested sugar beet, no optimum N rate was established.

Justification: Nitrogen application is one of the most important factors in producing good quality sugar beet. Kaffka 2007 reported that the optimum N application rate for sugar beets harvested in June and July was 220 lb N/A with another 100 lb nitrate-N/A in the surface 43 inches of soil at planting. A number of research reports can be found on the Spreckels Sugar website (www.spreckelsugar.com) on recent field research on N application in the Imperial Valley. The research by Lamb, Santiago, and Bloomquist, resulted in varied responses from the use of N fertilizer in the Imperial Valley from 2012 to 2021. This report is a summary of these trial results.

Objective: To collect N fertilizer rate response information for sugar beet grown in the Imperial Valley of California.

Procedures: The sixteen sites were parts of several N management studies. The objectives of these studies included the effect of slow-release N products, the interaction of N and K fertilizer, the interaction of N and application timing, and the interaction of N and variety on sugar beet growth and quality. The general results were

1. The use of slow-release fertilizer N sources did affect sugar beet N response,
2. The use of K fertilizer with N did affect sugar beet response to N application,
3. The application timing of N was not important, and finally,
4. N response was not affected by sugar beet variety.

From each study, the root yield, extractable sucrose per ton, and extractable per acre were taken from the data and statistically analyzed against N fertilizer application rate and the soil test nitrate-N to four foot plus broadcast pre-plant N application from phosphate fertilizers. The site number, production year, soil test N plus pre-plant N fertilizer, and harvest date are listed in Table 1. The sites ranged in soil test nitrate-N plus pre-plant broadcast fertilizer applications from 60 to 324 lb N per acre. Four of the 16 sites were harvested during the early harvest period (April through mid-June) and 12 of the 16 sites were harvested during the late harvest period (mid-June through the end of July). The plots were planted from September to October in the fall of the production year and harvested between April 4 to mid-July. Each plot was harvested with a plot size machine harvester to determine root yield. Root samples were taken for a quality analysis performed by the Spreckels Sugar quality lab in Brawley, California.

Table 1. Site characteristics for N responses in the Imperial Valley, 2012-2021.

Site	Year	Soil test N plus pre-plant N fertilizer	Harvest date
		lb N/A	
1	2012-2013	188	Early June (early)
2	2013-2014	128	July (late)
3	2014-2015	128	July (late)
4	2014-2015	127	July (late)
5	2014-2015	127	Late June/early July (late)
6	2014-2015	128	Late June/early July (late)
7	2015-2016	106	Late June/early July (late)
8	2013-2014	104	Late June/early July (late)
9	2013-2014	128	Late June/ early July (late)
10	2016-2017	60	July 4 (late)
11	2017-2018	91	Late June (late)
12	2018-2019	128	June 12 (early)
13	2018-2019	111	June 28 (late)
14	2019-2020	302	April 6 (early)
15	2020-2021	331	June 3 (early)
16	2020-2021	324	July 7 (late)

Results and Discussion: Root yield was significantly affected by N application at nine of the 16 sites, Table 2. Extractable sucrose per ton, a quality measurement, was affected by N application at 13 of the 16 sites, and extractable sucrose per acre, a combination of root yield and quality, was affected by N application at 7 of the 16 sites.

Root yield: Root yield was affected by N application rate at nine of the 16 sites years. Of those significantly affected sites, three were early harvest while six were late harvested locations.

Regression analysis was used to combine the results from the responsive sites. Figure 1 shows that the relationship between soil nitrate-N to a depth of 4 feet and the relative root yield for the significantly responsive root yield sites was linear and significant at the 0.02 level, R^2 = 0.0954. The relationship between N fertilizer application and relative root yield was linear and significant at the 0.0001 with a R^2 of 0.28. In both cases there was not an optimum N rate. As the amount of fertilizer N was applied the root yield increased.

Table 2. Statistical analysis for N fertilizer application from 2012-2021.

			Nitrogen fertilizer response		
Site	Year	Soil test N plus pre-plant N fertilizer	Root yield	Extractable sucrose	
				lb/ton	lb/acre
		lb N/A	P>f		
1	2012-2013	188	0.05	0.10	0.02
2	2013-2014	128	0.10	0.0001	0.17
3	2014-2015	128	0.87	0.11	0.18
4	2014-2015	127	0.38	0.10	0.20
5	2014-2015	127	0.0002	0.02	0.0002
6	2014-2015	128	0.51	0.02	0.56
7	2015-2016	106	0.99	0.13	0.22
8	2013-2014	104	0.01	0.24	0.01
9	2013-2014	128	0.0005	0.0001	0.36
10	2016-2017	60	0.33	0.0001	0.10
11	2017-2018	91	0.0001	0.001	0.0002
12	2018-2019	128	0.0001	0.0001	0.0001
13	2018-2019	111	0.009	0.0005	0.38
14	2019-2020	302	0.0008	0.002	0.09
15	2020-2021	331	0.52	0.03	0.35
16	2020-2021	324	0.49	0.0001	0.67

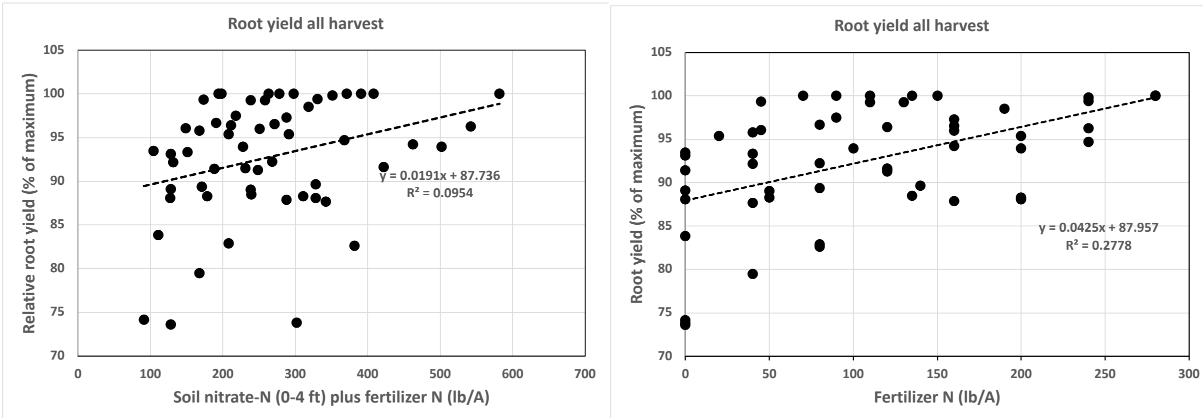

Figure 1. The relationship between soil nitrate-N plus fertilizer N and relative root yield (left graph) and the relationship between fertilizer N and relative root yield (right graph).

In the past, there have been different N fertilizer recommendations for sugar beet in the Imperial Valley, one for early harvested crop and one for late harvested crop. An early harvest is considered when the crop is harvested between April 1 and June 15 while late harvest is between June 16 and August 1. The differences in responses between the early and late harvest crops and the use of soil nitrate-N are reported in Figures 2 and 3.

For early harvested sugar beet root yield, the use of fertilizer N gave the best relationship compared to the use of soil nitrate-N plus fertilizer N, Fig. 2. In both situations, the relationship was linear, and the models were significant at the 0.007 R^2 = 0.31 and 0.0009 R^2 = 0.43 for soil nitrate-N plus fertilizer N and fertilizer N, respectively.

For the root yield at late harvest, the use of soil nitrate-N plus fertilizer N did a better job of predicting N application needs, Fig. 3. The root yield response was significant at the 0.0001 level with an R^2 = 0.42 using soil nitrate-N plus fertilizer N while using only fertilizer N the significance was 0.0014 and R^2 = 0.34. In both cases the response was curvilinear with an optimum N rate of 325 lb soil nitrate-N (0 to 4 ft.) plus fertilizer N and 224 lb fertilizer N/A.

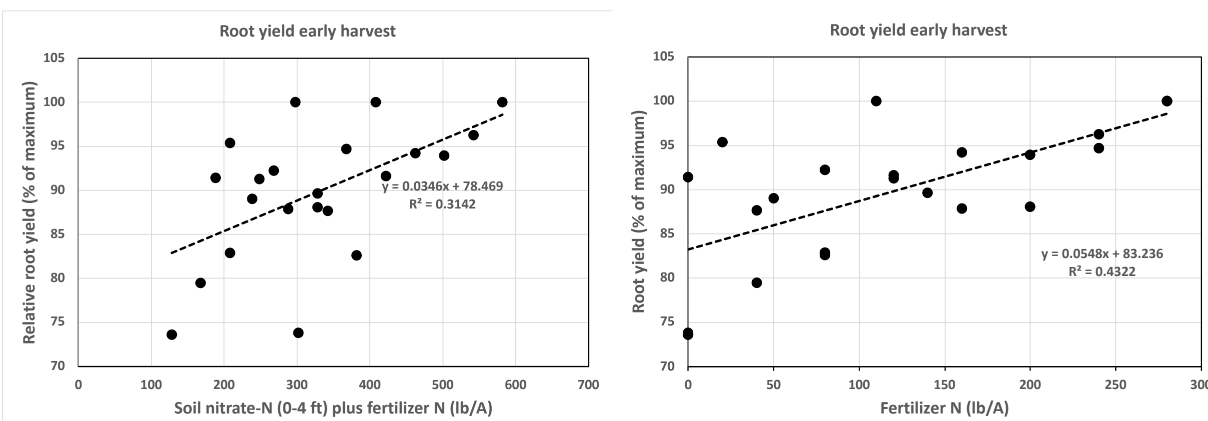

Figure 2. The relationship between soil nitrate-N plus fertilizer N and relative root yield (left graph) and the relationship between fertilizer N and relative root yield (right graph) for early harvest dates.

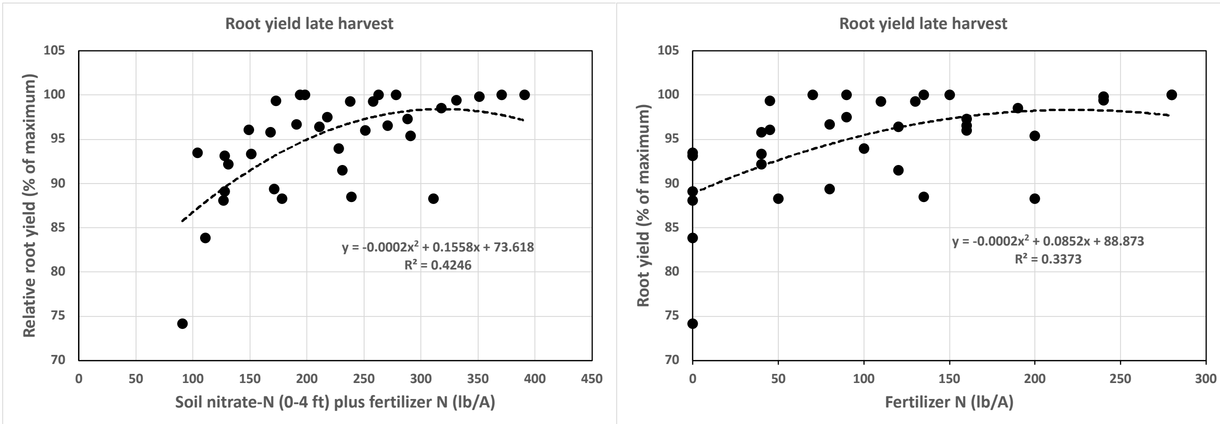

Figure 3. The relationship between soil nitrate-N plus fertilizer N and relative root yield (left graph) and the relationship between fertilizer N and relative root yield (right graph) for late harvest dates.

When comparing early versus late harvest for root yield response, just fertilizer N is a better predictor for the early harvest while the use of soil nitrate-N to a depth of 4 feet plus fertilizer N is a better recommendation for the late harvest root yield. For early harvest sugar beet root yield there is no optimum N rate application rate.

Extractable sucrose per ton: Extractable sucrose per ton, a quality measurement, was affected by N application at 13 of the 16 sites. Of the 13 sites, four sites were early harvest and nine were late harvest sites. The increase of nitrogen fertilizer decreased extractable sucrose per ton (quality), Fig. 4, for sugar beet harvested at both early and late. The use of soil nitrate-N to help predict the fertilizer N needs was not strong. The use of N fertilizer was best related to relative extractable sucrose per ton at 0.0001 and R^2 = 0.34.

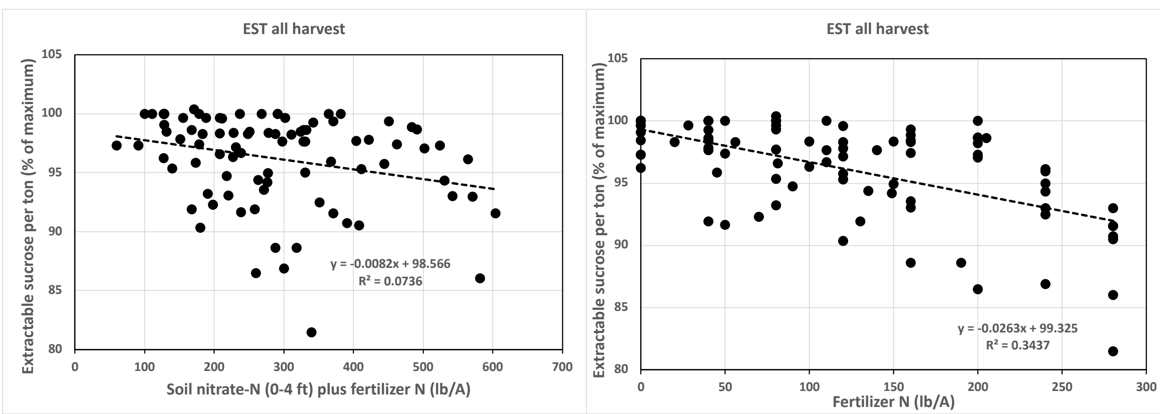

Figure 4. The relationship between soil nitrate-N plus fertilizer N and relative extractable sucrose per ton (left graph) and the relationship between fertilizer N and relative extractable sucrose per ton (right graph) for all harvest dates.

Nitrogen fertilizer reduced extractable sucrose particularly at the four early harvest sites, Fig. 5. While there is a relationship between soil nitrate-N plus fertilizer N and relative extractable sucrose per ton, the relationship between Fertilizer N was better, 0.0001 and R^2 = 0.58. The relationship between fertilizer N on extractable sucrose per ton is greater for early harvest site than at late harvest sites, Fig 4 and 5.

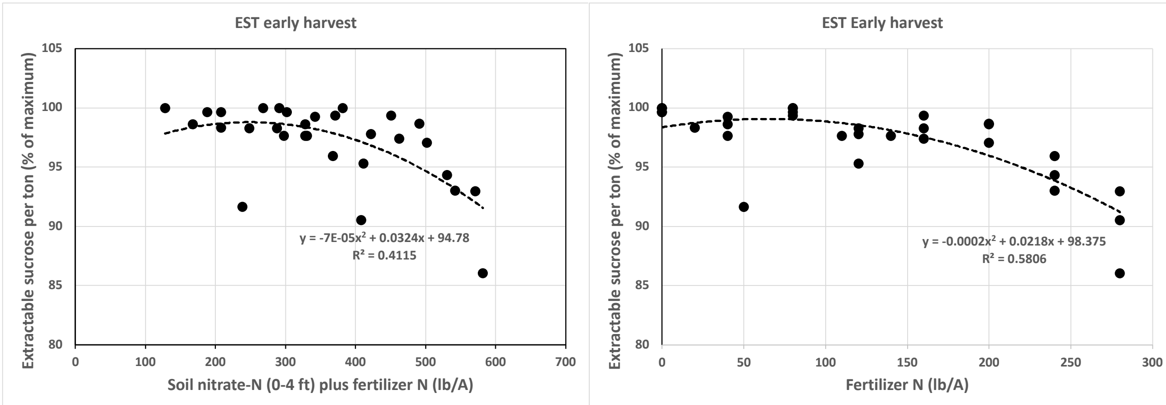

Figure 5. The relationship between soil nitrate-N plus fertilizer N and relative extractable sucrose per ton (left graph) and the relationship between fertilizer N and relative extractable sucrose per ton (right graph) for all early dates.

Like early harvest, the relationship between fertilizer N and extractable sucrose per ton is better than soil nitrate-N plus fertilizer N and extractable sucrose per ton, 0.0001, R^2 = 0.34 vs 0.03, R^2 = 0.08, Fig. 6.

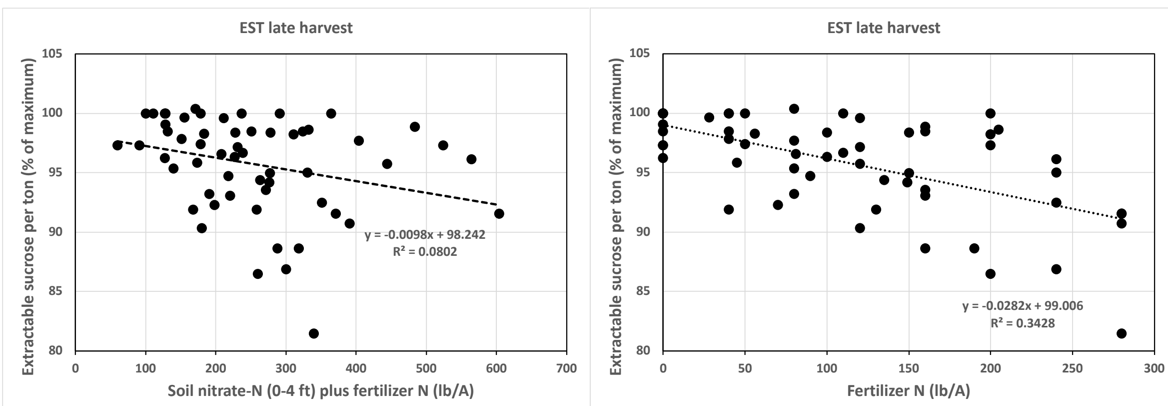

Figure 6. The relationship between soil nitrate-N plus fertilizer N and relative extractable sucrose per ton (left graph) and the relationship between fertilizer N and relative extractable sucrose per ton (right graph) for late harvest dates.

Extractable sucrose per acre: Extractable sucrose per acre, a combination of root yield and quality, was affected by N application at 7 of the 16 sites. Three of the responsive sites were early harvest and four sites were late harvest.

The relationship between extractable sucrose per acre and soil nitrate-N plus fertilizer N and the relationship between extractable sucrose per acre and fertilizer N are reported in Fig. 7. The relationship was stronger with just fertilizer N compared to soil nitrate-N plus fertilizer N, 0.0019, R^2 = 0.25 versus 0.09, R^2 = 0.07, respectively. The relationship between fertilizer N and extractable sucrose per acre is curvilinear with the optimum fertilizer N application of 186 lb N/A.

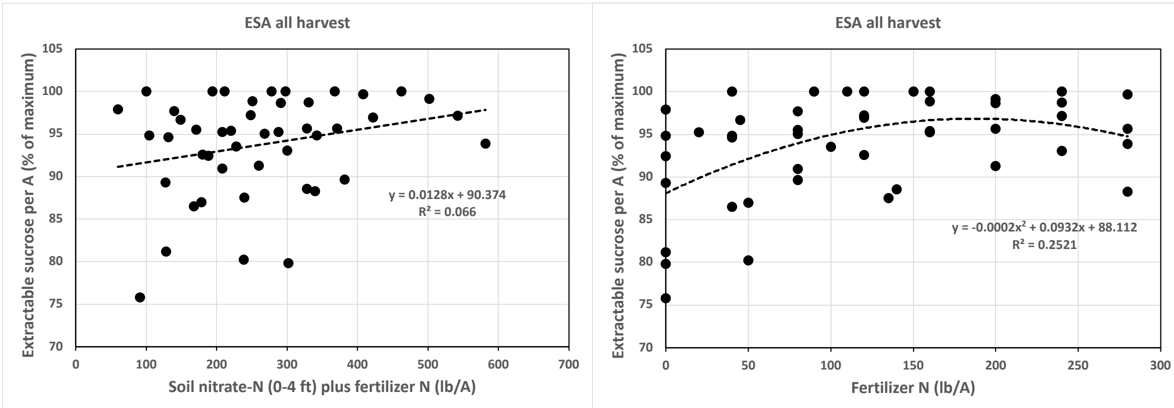

Figure 7. The relationship between soil nitrate-N plus fertilizer N and relative extractable sucrose per acre (left graph) and the relationship between fertilizer N and relative extractable sucrose per ton (right graph) for all harvest dates.

The relationship for the early harvest sites between soil nitrate-N plus fertilizer N and extractable sucrose per acre and fertilizer N and extractable sucrose per acre is stronger than for all sites considered together and the late harvest sites, Fig. 8. The use of fertilizer N rate is a better predictor for optimum N fertilizer rate than the use of soil nitrate-N plus fertilizer N. The relationship with fertilizer N is curvilinear, 0.0021, R^2 = 0.48 and an optimum rate of 231 lb N/A.

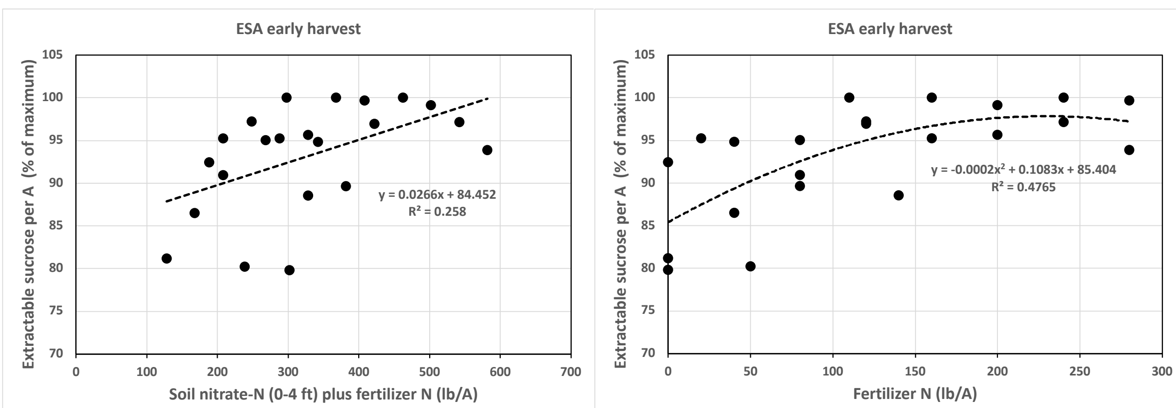

Figure 8. The relationship between soil nitrate-N plus fertilizer N and relative extractable sucrose per acre (left graph) and the relationship between fertilizer N and relative extractable sucrose per ton (right graph) for early harvest dates.

When combining the late harvest responsive sites, there is no relationship between either soil nitrate-N plus fertilizer N or just fertilizer N and extractable sucrose per acre, Fig. 9.

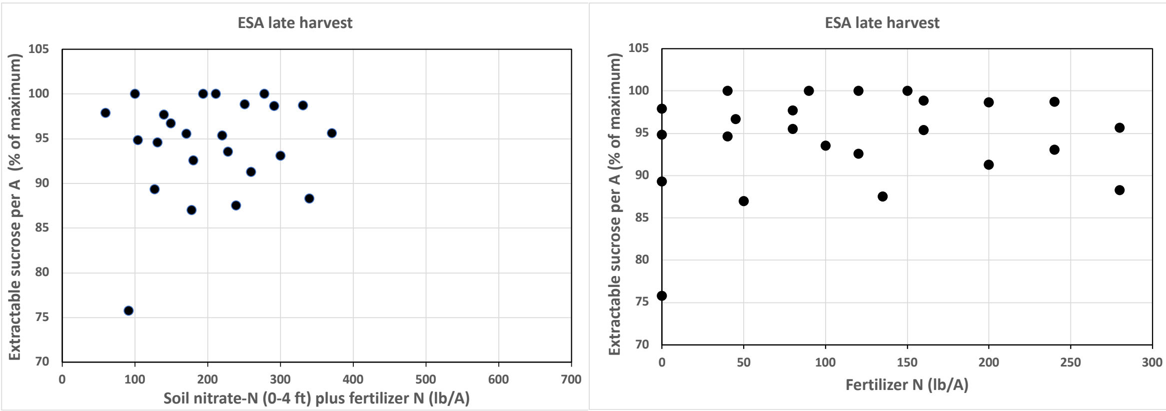

Figure 9. The relationship between soil nitrate-N plus fertilizer N and relative extractable sucrose per acre (left graph) and the relationship between fertilizer N and relative extractable sucrose per ton (right graph) for late harvest dates.

Summary: This report covers the results of N fertilizer application studies conducted on sugar beet grown in the Imperial Valley of California from 2012 to 2021. There were 16 sites in these studies harvested. Four of those sites were harvested during the early harvest period and 12 sites were harvested during the late harvest period. Root yield was significantly affected by N application at nine of the 16 sites. Extractable sucrose per ton, a quality measurement, was affected by N application at 13 of the 16 sites, and extractable sucrose per acre, a combination of root yield and quality, was affected by N application at 7 of the 16 sites. The early harvest sites were affected by N application more than the late harvest sites. The data was combined using only sites that were significantly affected by N application. The data was then combined using regression analyses for soil nitrate-N to 4 feet plus fertilizer N applied and just fertilizer N applied. The regression models reported were significant.

For root yield, when comparing early versus late harvest for root yield response, just fertilizer N is a better predictor for the early harvest while the use of soil nitrate-N to a depth of 4 feet plus fertilizer N is a better recommendation for the late harvest root yield. For early harvest sugar beet root yield there is no optimum N rate application rate.

The relationship between extractable sucrose per ton at all sites, early harvest sites, and late harvest sites, and fertilizer N is better than soil nitrate-N plus fertilizer N. As fertilizer N application is increased the extractable sucrose per ton (quality) is reduced.

For all responsive sites, the relationship for extractable sucrose per acre was stronger with just fertilizer N compared to soil nitrate-N plus fertilizer N. The relationship between fertilizer N and extractable sucrose per acre was curvilinear with the optimum fertilizer N application of 186 lb N/A.

The relationship between soil nitrate-N plus fertilizer N and extractable sucrose per acre is strongest for the sites that were in the early harvest group compared to the late harvest sites and the combined early and late harvest sites. The use of only fertilizer N rate is a better predictor for optimum N fertilizer rate than the use of soil nitrate-N plus fertilizer N for early harvest sites. The relationship with fertilizer N was curvilinear with an optimum rate of 231 lb N/A.

When combining the late harvest responsive sites, there is no relationship between either soil nitrate-N plus fertilizer N or just fertilizer N and extractable sucrose per acre. Fertilizer N application is more important for sugar beet extractable sucrose per acre grown for early harvest than for sugar beet harvested late.

At this time, the optimum N rate for early harvest sugar beet is 231 lb N/A and no optimum N rate was established for late-harvested sugar beet.

Literature Cited:

Kaffka, S.R., 2007. Fertilizer N management for high-yielding sugar beets in California. Proceedings of IIRB Summer Congress, Marrakech, Morocco. Brussels, Belguim: International Institute for Beet Research.

Reports found on the Spreckels Sugar website under the Research Reports tab:

Lamb, John, 2015. The Use of Slow Release Nitrogen Management for Sugar Beet Production in the Imperial Valley of California.

Lamb, John A. 2015. Nitrogen and Potassium Effects on Sugar Beet Quality.

Lamb, John A., Israel Santiago, and Mark Bloomquist. 2018. Nitrogen rate and timing study in Imperial Valley 2017-2018 growing season.

Santiago, Israel, Mark Bloomquist, and John Lamb. 2017. Nitrogen rate study conducted at Imperial Valley Research Center 2016 – 2017.

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California Beet Growers Association

2022-2023 Imperial Valley Official Variety Trial Procedures

Mark Bloomquist and Joaquin Santiago
Spreckels Sugar Company Inc.

Four Official Variety Trial locations were planted. Two of these trials were planted on early harvest fields, and two of the trials were planted on late harvest fields. Trials were planted with an ERMAS vacuum planter. Plots were two 30"-rows wide by twenty-five feet long. Each variety was replicated eight times across each trial. The experimental design of the trials was a randomized complete block. Emergence counts were taken approximately 21-28 days after planting. After the emergence counts were taken, plots were thinned to a uniform spacing, and all doubles were removed. Final stand counts were taken following thinning.

Weed control, insect control, and disease control applications were applied by the trial cooperator to match the practices of the field. Weed escapes were removed throughout the season to prevent competition with the sugar beets.

Before harvest, row lengths were taken on each harvest row to calculate yield at harvest. All plots were defoliated using a 4-row defoliator with scalpers. Each two-row plot was harvested using a 2-row research harvester. All beets harvested from the two rows were weighed on a scale on the harvester, and a sample of beets was taken for quality analysis at the Spreckels Sugar Tare Lab.

All varieties in their second year of testing and beyond were entered into various disease nurseries to evaluate the disease tolerance of the varieties. Rhizomania was evaluated at the Beet Sugar Development Foundation's Rhizomania Nursery by Dr. Carl Strausbaugh in Kimberly, Idaho. Dr. Stephen Kaffka evaluated Powdery Mildew at the DREC in Holtville, California. The mildew trial was abandoned due to low disease development.

Data is summarized and merged with the previous two years to evaluate the varieties for approval. The Imperial Valley Policy sets out guidelines for minimum performance standards of the varieties. Varieties that meet all the approval criteria are approved for shareholders to plant their 2023-2024 sugar beet crop.

2022-2023 Imperial Valley Official Variety Trial Locations

Trial Name	Cooperator	Canal/Gate	Plant Date	Harvest Date
Early Harvest Loc. 1	Ruegger Farms	Trifolium 8-143	9/20/22	4/17/23
Early Harvest Loc. 2	Jason Taylor	Nettle 3	9/29/22	5/15/23
Late Harvest Loc. 1	Dan Walker	Trifolium 9-173	10/13/22	7/18/23
Late Harvest Loc. 2	Steve Veysey	Newside 36W	10/21/22	6/20/23

SPRECKELS
Research

Imperial Valley Early Harvest Official Variety Trials
3 Year Data (2021-2023)

Variety	Approval Status for 2023-24 crop	Extractable Sugar/Acre	Extractable Sugar/Ton	Gross Sugar/Acre	Tons/Acre	% Sugar	Purity	Final Stand**	% Bolt	Percent Emergence*		Curly Top	% of Mkt.	Powdery Mildew***#	% of Mkt. Avg.	Rhizomania Root Rating##
BTS 511N	Full Approval															
2023 Trial		14,639	301.8	17,423	48.4	18.0	90.0	160	0.0	35.7		--	--	2.6	76.5	2.0
2022 Trial		9,945	264.0	12,562	37.8	16.7	86.5	212	0.0	53.0		5.2	98.1	--	--	1.8
2021 Trial		12,020	292.0	14,391	40.8	17.5	89.7	224	0.0	57.2		--	--	7.5	105.6	--
		12,201	285.9	14,792	42.3	17.4	88.7	199	0.0	48.6						
SV 983	Full Approval															
2023 Trial		13,257	284.4	15,900	46.6	17.1	89.7	100	0.0	15.5		--	--	2.8	82.4	3.2
2022 Trial		9,940	266.4	12,454	37.3	16.7	87.0	202	0.0	38.1		5.5	103.8	--	--	2.7
2021 Trial		12,329	286.6	14,676	42.9	17.1	89.8	223	0.0	42.4		5.8		6.4	90.1	2.4
		11,842	279.1	14,343	42.3	17.0	88.8	175	0.0	32.0						
SV 1915																
2023 Trial		15,313	285.2	18,495	54.1	17.1	89.5	172	0.0	51.1		--	--	3.7	108.8	2.5
2022 Trial		9,846	261.7	12,443	37.9	16.5	86.8	211	0.0	49.6		5.3	100.0	--	--	2.7
2021 Trial		12,326	287.9	14,697	43.0	17.2	89.8	224	0.0	50.2		--	--	6.1	85.9	--
		12,495	278.3	15,212	45.0	16.9	88.7	202	0.0	50.3						
BTS 5678	Full Approval															
2023 Trial		15,769	278.7	18,888	57.1	16.7	90.1	173	0.0	47.6		--	--	3.6	105.9	1.8
2022 Trial		10,573	267.1	13,245	39.4	16.8	87.0	213	0.0	54.5		5.1	96.2	--	--	2.0
2021 Trial		12,097	282.0	14,499	42.7	16.9	89.7	222	0.0	38.4		5.9		7.4	104.2	2.0
Average		12,813	275.9	15,544	46.4	16.8	88.9	203	0.0	46.8						
BTS 5460	Full Approval															
2023 Trial		15,548	277.7	18,520	56.1	16.6	90.1	171	0.0	53.5		--	--	4.1	120.6	2.2
2022 Trial		9,910	261.2	12,490	38.0	16.5	86.7	213	0.0	52.0		5.3	100.0	--	--	1.9
2021 Trial		11,512	280.4	13,878	40.8	16.9	89.5	223	0.0	48.3		5.6		7.8	109.9	2.1
Average		12,323	273.1	14,963	45.0	16.7	88.8	202	0.0	51.3						
SV 602	Full Approval															
2023 Trial		16,142	267.1	19,519	61.2	16.2	89.3	154	0.0	31.0		--	--	3.9	114.7	2.4
2022 Trial		10,602	255.8	13,293	41.4	16.1	87.1	211	0.0	49.4		5.4	101.9	--	--	2.8
2021 Trial		12,398	269.8	14,867	45.8	16.2	89.7	221	0.0	43.1		6.0	103.0	6.4	90.1	2.6
Average		13,047	264.2	15,893	49.5	16.2	88.7	195	0.0	41.2						
SV 911	Limited Approval															
2023 Trial		15,259	266.3	18,376	57.7	16.1	89.7	160	0.0	33.2		--	--	4.2	123.5	2.3
2022 Trial		10,361	252.9	13,073	41.0	16.0	86.8	212	0.0	50.2		5.3	100.0	--	--	2.7
2021 Trial		12,770	267.2	15,387	47.7	16.2	89.4	222	0.0	44.1		--	--	7.2	101.4	--
		12,797	262.1	15,612	48.8	16.1	88.6	198	0.0	42.5						

		Extractable Sugar/Acre	Extractable Sugar/Ton	Gross Sugar/Acre	Tons/Acre	% Sugar	Purity
Mean of Fully Approved (23-24)		12,445	275.7	15,107	45.1	16.8	88.8
97% of Fully Approved (23-24)		12,072	267.4	14,654	43.7	16.3	86.1

Mean of Fully Approved Varieties	Curly Top	% of Mkt.	Powdery Mildew	% of Mkt. Avg.	Rhizomania Root Rating
2023 Mean	--	--	3.4	100.0	2.3
2022 Mean	5.3	100.0	--	--	2.2
2021 Mean	5.8	100.0	7.1	100.0	2.3

	Extractable Sugar/Acre	Extractable Sugar/Ton	Gross Sugar/Acre	Tons/Acre	% Sugar	Purity	Final Stand	% Bolt	Percent Emergence	Curly Top	Powdery Mildew	Rhizomania Root Rating
CV%												
2023 Trial	2.4	1.6	2.6	3.6	1.3	0.5	3.1	--	12.7	--	15.7	--
2022 Trial	2.9	2.3	2.5	2.5	1.9	0.6	7.6	--	2.3	5.1	--	--
2021 Trial	5.4	2.2	5.1	4.9	1.7	0.8	2.3	--	8.3	7.0	7.7	n/a
LSD (0.05)												
2023 Trial	752.2	9.7	990.4	4.1	0.5	0.9	10.8	--	11.6	--	0.7	0.2
2022 Trial	587.0	NS	640.8	2.0	NS	NS	8.1	--	NS	0.4	--	0.3
2021 Trial	428.1	4.2	491.4	1.4	0.2	0.5	3.6	--	2.8	0.5	0.6	0.5

Cooperator	Planted	Harvested	Plot Size	Notes:
Ruegger Farms	9/20/22	4/17/23	2 rows. 30" rows.	Experimental Design: RCBD
Jason Taylor	9/29/22	5/15/23	2 rows. 30" rows.	Experimental Design: RCBD
Horizon Farms	9/15/21	3/30/22	2 rows. 30" rows.	Experimental Design: RCBD
Lance Reeves	9/25/21	4/6/22	2 rows. 30" rows.	Experimental Design: RCBD
Russell Allen	9/23/20	4/13-14/21	2 rows. 30" rows.	Experimental Design: RCBD
Brian Hair	10/28/20	5/17-18/21	2 rows. 30" rows.	Experimental Design: RCBD

Varieties ranked by Extractable Sugar per Ton.

* Emergence counts taken prior to thinning and converted to a percent.

** Final Stand counts converted to beets per 100 foot of row. Final stand counts taken after thinning.

*** 2021 Powdery mildew ratings are average of two raters at 2021 EH Location 2 yield trial. Ratings on 1-9 scale. 1=low disease, 9 = high disease

2023 Powdery mildew ratings were taken from EH Location 2 on 5/9/23 on a 1-9 rating scale.

Root rating using 0-9 scale (0=healthy and 9=dead; ≥ 3 would be considered susceptible.

Imperial Valley Early Harvest Official Variety Trials
2 Year Data (2022-2023)

Variety		Approval Status for 2023-24 crop	Extractable Sugar/Acre	Extractable Sugar/Ton	Gross Sugar/Acre	Tons/ Acre	% Sugar	Purity	Final Stand**	% Bolt	Percent Emergence*		Curly Top	% of Mkt.	Powdery Mildew#	% of Mkt.	Rhizomania Root Rating##
BTS 511N		Full Approval															
	2023 Trial		14,639	301.8	17,423	48.4	18.0	90.0	160	0.0	35.7		--	--	2.6	76.5	2.0
	2022 Trial		9,945	264.0	12,562	37.8	16.7	86.5	212	0.0	53.0		5.2	98.1	--	--	1.8
Average			12,292	282.9	14,993	43.1	17.4	88.3	186.0	0.0	44.4						
BTS 5255																	
	2023 Trial		15,813	282.8	18,796	56.2	16.8	90.5	175	0.0	44.7		--	--	3.1	91.2	2.2
	2022 Trial		10,819	272.7	13,471	39.4	17.0	87.2	214	0.0	53.4		--	--	--	--	--
			13,316	277.8	16,133	47.8	16.9	88.9	194.5	0.0	49.1						
SV 983		Full Approval															
	2023 Trial		13,257	284.4	15,900	46.6	17.1	89.7	100	0.0	15.5		--	--	2.8	82.4	3.2
	2022 Trial		9,940	266.4	12,454	37.3	16.7	87.0	202	0.0	38.1		5.5	103.8	--	--	2.7
Average			11,599	275.4	14,177	42.0	16.9	88.4	151.0	0.0	26.8						
SV 1927																	
	2023 Trial		15,551	287.3	18,568	55.1	17.1	90.0	172	0.0	51.3		--	--	4.3	126.5	2.3
	2022 Trial		10,161	263.0	12,703	38.7	16.5	87.2	212	0.0	58.5		--	--	--	--	--
			12,856	275.2	15,636	46.9	16.8	88.6	192.2	0.0	54.9						
SV 1915																	
	2023 Trial		15,313	285.2	18,495	54.1	17.1	89.5	172	0.0	51.1		--	--	3.7	108.8	2.5
	2022 Trial		9,846	261.7	12,443	37.9	16.5	86.8	211	0.0	49.6		5.3	100.0	--	--	2.7
Average			12,580	273.5	15,469	46.0	16.8	88.2	191.5	0.0	50.4						
BTS 5678		Full Approval															
	2023 Trial		15,769	278.7	18,888	57.1	16.7	90.1	173	0.0	47.6		--	--	3.6	105.9	1.8
	2022 Trial		10,573	267.1	13,245	39.4	16.8	87.0	213	0.0	54.5		5.1	96.2	--	--	2.0
Average			13,171	272.9	16,066	48.3	16.8	88.6	193.0	0.0	51.1						
BTS 5460		Full Approval															
	2023 Trial		15,548	277.7	18,520	56.1	16.6	90.1	171	0.0	53.5		--	--	4.1	120.6	2.2
	2022 Trial		9,910	261.2	12,490	38.0	16.5	86.7	213	0.0	52.0		5.3	100.0	--	--	1.9
Average			12,729	269.5	15,505	47.1	16.6	88.4	192.0	0.0	52.8						
SV 602		Full Approval															
	2023 Trial		16,142	267.1	19,519	61.2	16.2	89.3	154	0.0	31.0		--	--	3.9	114.7	2.4
	2022 Trial		10,602	255.8	13,293	41.4	16.1	87.1	211	0.0	49.4		5.4	101.9	--	--	2.8
Average			13,372	261.5	16,406	51.3	16.2	88.2	182.5	0.0	40.2						
SV 911		Limited Approval															
	2023 Trial		15,259	266.3	18,376	57.7	16.1	89.7	160	0.0	33.2		--	--	4.2	123.5	2.3
	2022 Trial		10,361	252.9	13,073	41.0	16.0	86.8	212	0.0	50.2		5.3	100.0	--	--	2.7
Average			12,810	259.6	15,725	49.4	16.1	88.3	186.0	0.0	41.7						

												Mean of Fully Approved Varieties					
Mean of Fully Approved (23-24)					15,429	46.3	16.7	88.4	180.9			2023 Mean	--	--	3.4	100.0	2.3
97% of Fully Approved (23-24)					14,966	44.9	16.2	85.7	175.5			2022 Mean	5.3	100.0	--	--	2.2
CV%																	
	2023 Trial		2.4	1.6	2.6	3.6	1.3	0.5	3.1	--	12.7		--		15.7		--
	2022 Trial		2.9	2.3	2.5	2.5	1.9	0.6	7.6	--	2.3		5.1		--		--
LSD (0.05)																	
	2023 Trial		752.2	9.7	990.4	4.1	0.5	0.9	10.8	--	11.6		--		0.7		0.2
	2022 Trial		587.0	NS	640.8	2.0	NS	NS	8.1	--	NS		0.4		--		0.3

Cooperator	**Planted**	**Harvested**	**Plot Size**	**Notes:**
Ruegger Farms	9/20/22	4/17/23	2 rows. 30" rows.	Experimental Design: RCBD
Jason Taylor	9/29/22	5/15/23	2 rows. 30" rows.	Experimental Design: RCBD
Horizon Farms	9/15/21	3/30/22	2 rows. 30" rows.	Experimental Design: RCBD
Lance Reeves	9/25/21	4/6/22	2 rows. 30" rows.	Experimental Design: RCBD

Varieties ranked by Extractable Sugar per Ton.

* Emergence counts taken prior to thinning and converted to a percent.

** Final Stand counts converted to beets per 100 foot of row. Final stand counts taken after thinning.

2023 Powdery mildew ratings were taken from 2023 EH Location 2 on 5/9/23 on a 1-9 rating scale.

Root rating using 0-9 scale (0=healthy and 9=dead; ≥ 3 would be considered susceptible.

Imperial Valley Early Harvest Official Variety Trials
1 Year Data (2023)

Variety	Approval Status for 2023-24 crop	Extractable Sugar/Acre	Extractable Sugar/Ton	Gross Sugar/Acre	Tons/ Acre	% Sugar	Purity	Final Stand**	% Bolt	Percent Emergence*	Powdery Mildew#	% of Mkt. Avg.	Rhizomania Root Rating##
SV 1934N		12,273	303.6	14,593	40.0	18.1	89.7	174	0.0	59.4	2.7	79.4	--
BTS 511N	Full Approval	14,639	301.8	17,423	48.4	18.0	90.0	160	0.0	35.7	2.6	76.5	2.0
BTS 5309		13,933	290.9	16,696	48.1	17.4	89.8	164	0.0	40.8	3.5	102.9	--
BTS 539N		14,113	289.2	16,923	49.0	17.4	89.5	162	0.0	37.0	3.5	102.9	--
SV 1927		15,551	287.3	18,568	55.1	17.1	90.0	172	0.0	51.3	4.3	126.5	2.3
SV 1915		15,313	285.2	18,495	54.1	17.1	89.5	172	0.0	51.1	3.7	108.8	2.5
BTS 5386		14,747	285.0	17,681	52.1	17.1	89.6	168	0.0	44.3	5.2	152.9	--
SV 983	Full Approval	13,257	284.4	15,900	46.6	17.1	89.7	100	0.0	15.5	2.8	82.4	3.2
BTS 5255		15,813	282.8	18,796	56.2	16.8	90.5	175	0.0	44.7	3.1	91.2	2.2
BTS 5350		14,923	280.8	17,969	54.1	16.9	89.7	173	0.0	45.1	2.9	85.3	--
BTS 5317		15,185	280.6	18,239	54.9	16.8	89.9	170	0.0	48.2	4.0	117.6	--
BTS 5678	Full Approval	15,769	278.7	18,888	57.1	16.7	90.1	173	0.0	47.6	3.6	105.9	1.8
BTS 5460	Full Approval	15,548	277.7	18,520	56.1	16.6	90.1	171	0.0	53.5	4.1	120.6	2.2
SV 602	Full Approval	16,142	267.1	19,519	61.2	16.2	89.3	154	0.0	31.0	3.9	114.7	2.4
SV 911	Limited Approval	15,259	266.3	18,376	57.7	16.1	89.7	160	0.0	33.2	4.2	123.5	2.3
Mean of Fully Approved (23-24)		15,071	281.9	18,050	53.9	16.9	89.8						
97% of Fully Approved (23-24)		14,619	273.5	17,508	52.3	16.4	87.1						
CV%		2.4	1.6	2.6	3.6	1.3	0.5	3.1	--	12.7	15.7		--
LSD (0.05)		752.2	9.7	990.4	4.1	0.5	0.9	10.8	--	11.6	0.7		0.2

Mean of Fully Approved Varieties			
2023 Mean	3.4	100.0	2.3

Cooperator	**Planted**	**Harvested**	**Plot Size**	**Notes:**
Ruegger Farms	9/20/22	4/17/23	2 rows. 30" rows.	Experimental Design: RCBD
Jason Taylor	9/29/22	5/15/23	2 rows. 30" rows.	Experimental Design: RCBD

Varieties ranked by Extractable Sugar per Ton.

* Emergence counts taken prior to thinning and converted to a percent.

** Final Stand counts converted to beets per 100 foot of row. Final stand counts taken after thinning.

2023 Powdery mildew ratings were taken from 2023 EH Location 2 on 5/9/23 on a 1-9 rating scale.

Root rating using 0-9 scale (0=healthy and 9=dead; ≥ 3 would be considered susceptible.

2022-2023 Imperial Valley Early Harvest Official Variety Trial Results - Combined Analysis

Entry	Entry Name	Extractable Sugar per Ton	Extractable Sugar per Acre	Gross Sugar per Acre	Tons per Acre	Percent Sugar	Extractable Sugar Percent	Percent Purity	Brei N (ppm)	Percent Tare	Percent* Emergence	Final Stand** Beets/100'
1	BTS 5460	277.7	15,548.4	18,519.8	56.1	16.6	13.9	90.1	41.0	3.4	53.5	170.6
2	BTS 5678	278.7	15,768.6	18,888.1	57.1	16.7	13.9	90.1	44.0	3.1	47.6	173.0
3	BTS 511N	301.8	14,638.6	17,422.8	48.4	18.0	15.1	90.0	43.4	4.4	35.7	159.7
4	BTS 5255	282.8	15,812.7	18,795.8	56.2	16.8	14.1	90.5	53.8	2.2	44.7	175.0
5	BTS 5309	290.9	13,933.0	16,696.0	48.1	17.4	14.5	89.8	33.9	3.2	40.8	164.1
6	BTS 5317	280.6	15,185.2	18,239.1	54.9	16.8	14.0	89.9	43.9	2.3	48.2	169.5
7	BTS 5350	280.8	14,923.2	17,968.6	54.1	16.9	14.0	89.7	60.9	2.6	45.1	173.1
8	BTS 5386	285.0	14,746.8	17,680.6	52.1	17.1	14.2	89.6	71.6	4.1	44.3	168.0
9	BTS 539N	289.2	14,113.1	16,922.9	49.0	17.4	14.5	89.5	37.9	2.2	37.0	161.8
10	SV 1915	285.2	15,312.8	18,495.0	54.1	17.1	14.3	89.5	47.3	2.9	51.1	171.6
11	SV 1927	287.3	15,551.2	18,568.0	55.1	17.1	14.4	90.0	63.5	1.9	51.3	172.3
12	SV 1934N	303.6	12,273.1	14,592.8	40.0	18.1	15.2	89.7	31.5	3.2	59.4	173.7
13	SV 602	267.1	16,141.6	19,518.7	61.2	16.2	13.4	89.3	56.7	1.3	31.0	153.9
14	SV 983	284.4	13,257.4	15,900.4	46.6	17.1	14.2	89.7	37.4	1.1	15.5	99.5
15	SV 911	266.3	15,258.8	18,375.5	57.7	16.1	13.3	89.7	50.6	1.3	33.2	159.5
	Mean	284.1	14,831.0	17,772.3	52.7	17.0	14.2	89.8	47.8	2.6	42.5	163.0
	Residual	20.3	122,402.9	212,186.7	3.6	0.1	0.1	0.2	124.9	0.4	29.2	25.3
	CV (%)	1.6	2.4	2.6	3.6	1.3	1.6	0.5	23.4	22.7	12.7	3.1
	LSD (0.05)	9.7	752.2	990.4	4.1	0.5	0.5	0.9	24.0	1.3	11.6	10.8

*Emergence counts taken prior to thinning and converted to a percent.

**Final stand counts taken after thinning and converted to beets per 100' of row.

Data reported is a combined analysis of the 2022-2023 Early Harvest OVT Location 1 and Location 2

Imperial Valley Late Harvest Official Variety Trials

3 Year Data (2021-2023)

Variety	2023-2024 Marketing Approval	Year	Extractable Sugar/ Acre	Extractable Sugar/Ton	Gross Sugar/ Acre	Tons/ Acre	% Sugar	Purity	Final Stand**	% Bolt	% Rot[w]	Percent Emergence*	Curly Top Rating	% of Mkt. Avg.	Powdery Mildew Rating[#]	% of Mkt. Avg.	Rhizomania Root Rating[##]
BTS 511N	Limited Approval	2023	20,193	291.5	24,279	67.2	17.6	89.4	239	0.0	0.6	47.6	--	--	5.2	66.2	2.0
		2022	20,623	294.1	24,614	71.6	17.5	90.4	232	0.0	1.5	43.1	5.2	100.0	--	--	1.8
		2021	18,053	310.4	21,014	58.5	18.0	91.9	233	0.0	0.0	63.4	--	--	6.6	91.0	--
		Average	19,623	298.7	23,302	65.8	17.7	90.6	235	0.0	0.7	51.4					
SV 1915	Limited Approval	2023	20,478	302.8	24,060	67.5	17.8	90.9	238	0.4	0.0	48.8	--	--	5.1	65.0	2.5
		2022	18,954	282.9	23,014	69.1	17.0	89.3	231	0.0	12.4	42.4	5.3	101.9	--	--	2.7
		2021	18,861	303.2	22,096	62.2	17.8	91.2	231	0.0	0.0	61.8	--	--	5.2	71.7	--
		Average	19,431	296.3	23,057	66.3	17.5	90.5	233	0.1	4.1	51.0					
Beta 5678	Full Approval	2023	20,981	294.3	24,688	71.6	17.3	91.0	239	0.0	0.1	55.7	--	--	7.9	100.6	1.8
		2022	18,995	288.0	22,703	66.6	17.1	90.0	232	0.0	9.0	45.1	5.1	98.1	--	--	2.0
		2021	17,311	302.3	20,147	57.4	17.6	91.7	232	0.0	0.0	49.2	5.9	102.6	7.6	104.8	2.0
		Average	19,096	294.9	22,513	65.2	17.3	90.9	234	0.0	3.0	50.0					
BTS 5460	Full Approval	2023	20,678	292.3	24,463	70.4	17.3	90.5	238	0.1	0.2	60.0	--	--	7.8	99.4	2.2
		2022	20,059	283.4	24,299	71.9	17.0	89.5	231	0.2	2.7	47.5	5.3	101.9	--	--	1.9
		2021	17,525	299.8	20,409	58.3	17.5	91.6	232	0.0	0.0	59.1	5.6	97.4	6.9	95.2	2.1
		Average	19,421	291.8	23,057	66.9	17.3	90.5	234	0.1	1.0	55.5					

	Extractable Sugar/ Acre	Extractable Sugar/Ton	Gross Sugar/ Acre	Tons/ Acre	% Sugar	Purity
Mean of Fully Approved (23-24)	19,258	293.4	22,785	66.0	17.3	90.7
97% of Fully Approved (23-24)	18,680	284.5	22,101	64.1	16.8	88.0

Mean of Fully Approved Varieties	Curly Top Rating	% of Mkt. Avg.	Powdery Mildew Rating	% of Mkt. Avg.	Rhizomania Root Rating
2023 Mean	--	--	7.9	100.0	2.0
2022 Mean	5.2	100.0	--	--	2.0
2021 Mean	5.8	100.0	7.3	100.0	2.1

	Year	Extractable Sugar/ Acre	Extractable Sugar/Ton	Gross Sugar/ Acre	Tons/ Acre	% Sugar	Purity	Final Stand	% Bolt	% Rot	Percent Emergence	Curly Top Rating	Powdery Mildew Rating	Rhizomania Root Rating
LSD (0.05)	2023	1176.1	7.7	1354.7	3.7	0.4	0.7	7.5	0.3	0.5	5.9	--	0.4	0.2
	2022	1081.4	6.6	1282.9	4.0	0.3	0.7	4.2	0.3	5.1	4.8	0.4	--	0.3
	2021	932.7	5.6	1071.7	3.1	0.2	0.6	5.2	--	--	5.3	0.5	0.5	0.5
C.V.	2023	5.1	2.4	5.0	4.7	1.8	0.7	3.0	143.0	199.4	10.0	--	5.6	--
	2022	8.6	3.4	8.5	9.0	2.6	1.1	2.6	315.4	30.1	15.9	5.1	--	--
	2021	4.7	1.8	4.6	4.5	1.3	0.6	2.1	--	--	8.9	7.0	6.9	--

Varieties ranked by Extractable Sugar per Ton

Disease nursery ratings: Lower numbers are more resistant, higher numbers are more susceptible.

* Emergence counts taken prior to thinning and converted to a percent.

** Final stand counts converted to beets per 100 foot of row. Final stand counts taken after thinning.

[#] 2021 Powdery mildew data is from 2020-2021 Late Harvest Loc. 2 yield trial. 2023 mildew data is from 2022-23 LH Loc. 1. Rating scale 1-9 with lower ratings meaning less disease and higher ratings meaning more disease.

[##] Root rating using a scale of 0-9 (0=healthy and 9=dead; ≥3 would be considered susceptible.

[w] 2022 Rot data is from Location #1 only. 2023 Rot data s from Location #1 only.

Cooperator	Planted	Harvested	Plot Size
Dan Walker	10/13/2022	7/18/2023	2 rows -- 30 inch rows
Ruegger Farms	10/6/2021	6/1/2022	2 rows -- 30 inch rows
Gary and Brett Mamer	10/13/2021	7/7/2022	2 rows -- 30 inch rows
Jason Taylor	10/12/2020	6/9/2021	2 rows -- 30 in. 4 x 4 lattice

Imperial Valley Late Harvest Official Variety Trials

2 Year Data (2022-2023)

Variety	2023-2024 Marketing Approval	Year	Extractable Sugar/ Acre	Extractable Sugar/ Ton[+]	Gross Sugar/ Acre	Tons/ Acre	% Sugar	Purity	Final Stand**	% Bolt	% Rot***	Percent Emergence*	Curly Top Rating	% of Mkt. Avg.	Powdery Mildew Rating[#]	% of Mkt. Avg.	Rhizomania Root Rating[##]
SV 1915	Limited Approval	2023	20,478	302.8	24,060	67.5	17.8	90.9	238	0.4	0.0	48.8	--	--	5.1	65.0	2.5
		2022	18,954	282.9	23,014	69.1	17.0	89.3	231	0.0	12.4	42.4	5.3	101.9	--	--	2.7
		Average	19,716	292.9	23,537	68.3	17.4	90.1	235	0.2	6.2	45.6					
BTS 511N	Limited Approval	2023	20,193	291.5	24,279	67.2	17.6	89.4	239	0.0	0.6	47.6	--	--	5.2	66.2	2.0
		2022	20,623	294.1	24,614	71.6	17.5	90.4	232	0.0	1.5	43.1	5.2	100.0	--	--	1.8
		Average	20,408	292.8	24,446	69.4	17.6	89.9	236	0.0	1.1	45.4					
BTS 5678	Full Approval	2023	20,981	294.3	24,688	71.6	17.3	91.0	239	0.0	0.1	55.7	--	--	7.9	100.6	1.8
		2022	18,995	288.0	22,703	66.6	17.1	90.0	232	0.0	9.0	45.1	5.1	98.1	--	--	2.0
		Average	19,988	291.2	23,695	69.1	17.2	90.5	236	0.0	4.6	50.4					
SV 1927		2023	19,760	296.0	23,432	66.3	17.6	90.2	233	1.6	0.1	45.8	--	--	5.9	75.2	2.3
		2022	18,971	282.7	22,934	67.8	17.0	89.6	233	0.3	17.4	43.5	--	--	--	--	--
		Average	19,365	289.4	23,183	67.1	17.3	89.9	233	1.0	8.8	44.7					
BTS 5460	Full Approval	2023	20,678	292.3	24,463	70.4	17.3	90.5	238	0.1	0.2	60.0	--	--	7.8	99.4	2.2
		2022	20,059	283.4	24,299	71.9	17.0	89.5	231	0.2	2.7	47.5	5.3	101.9	--	--	1.9
		Average	20,369	287.9	24,381	71.2	17.2	90.0	235	0.2	1.5	53.8					
BTS 5255		2023	20,240	288.3	24,117	69.9	17.2	90.0	239	0.0	0.2	48.2	--	--	7.0	89.2	2.2
		2022	20,856	286.4	24,944	73.8	17.0	90.2	233	0.0	0.4	44.4	--	--	--	--	--
		Average	20,548	287.4	24,530	71.9	17.1	90.1	236	0.0	0.3	46.3					

	Extractable Sugar/ Acre	Extractable Sugar/ Ton	Gross Sugar/ Acre	Tons/ Acre	% Sugar	Purity
Mean of Fully Approved (23-24)	20,178	289.5	24,038	70.1	17.2	90.3
97% of Fully Approved (23-24)	19,573	280.8	23,317	68.0	16.7	87.5

Mean of Fully Approved Varieties	Curly Top Rating	% of Mkt. Avg.	Powdery Mildew Rating	% of Mkt. Avg.	Rhizomania Root Rating
2023 Mean	--	--	7.9	100.0	2.0
2022 Mean	5.2	100.0	--	--	2.0

	Year	Extractable Sugar/ Acre	Extractable Sugar/ Ton	Gross Sugar/ Acre	Tons/ Acre	% Sugar	Purity	Final Stand	% Bolt	% Rot	Percent Emergence	Curly Top Rating	Powdery Mildew Rating	Rhizomania Root Rating
LSD (0.05)	2023	1,176.1	7.7	1,354.7	3.7	0.4	0.7	7.5	0.3	0.5	5.9	--	0.4	--
	2022	1,081.4	6.6	1,282.9	4.0	0.3	0.7	4.2	0.3	5.1	4.8	0.4	--	0.3
C.V.	2023	5.1	2.4	5.0	4.7	1.8	0.7	3.0	143.0	199.4	10.0	--	5.6	--
	2022	8.6	3.4	8.5	9.0	2.6	1.1	2.6	315.4	30.1	15.9	5.1	--	--

Varieties ranked by Extractable Sugar per Ton

Disease nursery ratings: Lower numbers are more resistant, higher numbers are more susceptible.

* Emergence counts taken prior to thinnng and converted to a percent.

**Final stand counts converted to beets per 100 foot of row. Final stand counts taken after thinning.

***2022 Percent rot is from LH OVT Location #1 only. No rot present at Location #2.

[#] 2023 Powdery mildew data is from ratings taken at 2022-2023 Late Harvest Loc. 1 yield trial. Rating scale 1-9 with lower ratings meaning less disease and higher ratings meaning more disease.

[##] Root rating using a scale of 0-9 (0=healthy and 9=dead; ≥3 would be considered susceptible.

Cooperator	Planted	Harvested	Plot Size
Dan Walker	10/13/2022	7/18/2023	2 rows -- 30 inch rows
Ruegger Farms	10/6/2021	6/1/2022	2 rows -- 30 inch rows
Gary and Brett Mamer	10/13/2021	7/7/2022	2 rows -- 30 inch rows

Imperial Valley Late Harvest Official Variety Trials

1 Year Data Summary (2023)

Variety	2023-2024 Marketing Approval	Extractable Sugar/ Acre	Extractable Sugar/Ton	Gross Sugar/ Acre	Tons / Acre	% Sugar	Purity	Final Stand**	% Bolt	% Rot***	Percent Emergence*	Powdery Mildew#	% of Mkt. Avg.	Rhizomania Root Rating##
BTS 5386		20,794	307.7	24,361	68.0	18.1	91.0	237	0.3	0.1	53.3	7.7	98.1	--
SV 1934N		17,908	307.3	21,264	57.6	18.3	90.1	239	0.5	0.5	57.6	4.5	57.3	--
BTS 5309		19,249	307.0	22,599	62.4	18.0	91.0	234	0.1	0.2	50.4	7.7	98.1	--
BTS 539N		19,222	305.9	22,701	62.4	18.0	90.6	234	0.0	0.4	45.6	5.9	75.2	--
SV 1915	Limited Approval	20,478	302.8	24,060	67.5	17.8	90.9	238	0.4	0.0	48.8	5.1	65.0	2.5
SV1927		19,760	296.0	23,432	66.3	17.6	90.2	233	1.6	0.1	45.8	5.9	75.2	2.3
BTS 5678	Full Approval	20,981	294.3	24,688	71.6	17.3	91.0	239	0.0	0.1	55.7	7.9	100.6	1.8
BTS 5460	Full Approval	20,678	292.3	24,463	70.4	17.3	90.5	238	0.1	0.2	60.0	7.8	99.4	2.2
BTS 511N	Limited Approval	20,193	291.5	24,279	67.2	17.6	89.4	239	0.0	0.6	47.6	5.2	66.2	2.0
BTS 5350		19,464	288.4	23,201	66.9	17.2	90.1	235	0.0	0.3	50.0	6.4	81.5	--
BTS 5255		20,240	288.3	24,117	69.9	17.2	90.0	239	0.0	0.2	48.2	7.0	89.2	2.2
BTS 5317		18,938	284.0	22,558	67.0	16.9	90.2	238	0.0	0.2	56.1	7.7	98.1	--

		Extractable Sugar/ Acre	Extractable Sugar/Ton	Gross Sugar/ Acre	Tons / Acre	% Sugar	Purity
Mean of Fully Approved (23-24)		20,830	293.3	24,575	71.0	17.3	90.8
97% of Fully Approved (23-24)		20,205	284.5	23,838	68.9	16.8	88.0
	LSD (0.05)	1,176.1	7.7	1,354.7	3.7	0.4	0.7
	C.V.	5.1	2.4	5.0	4.7	1.8	0.7

Mean of Fully Approved Varieties	Powdery Mildew	% of Mkt. Avg.	Rhizomania Root Rating
2023 Mean	7.9	100.0	2.0
LSD (0.05)	0.4		
C.V.	5.6		

Varieties ranked by Extractable Sugar per Ton.

Disease nursery ratings: Lower numbers are more resistant, higher numbers are more susceptible.

*Emergence counts taken prior to thinning and converted to a percent.

**Final stand counts converted to beets per 100 foot of row. Final stand counts taken after thinning.

*** Percent rot is calculated by counting rot beets per plot and converting to a percent based on the final stand count.

#2023 mildew data is from 2022-23 LH Loc. 1. Rating scale 1-9 with lower ratings meaning less disease and higher ratings meaning more disease.

Root rating using a scale of 0-9 (0=healthy and 9=dead; ≥3 would be considered susceptible.

Cooperator	Planted	Harvested	Plot Size
Dan Walker	10/13/2022	7/18/2023	2 rows -- 30 inch rows

2022-2023 Imperial Valley Late Harvest Official Variety Trial Results - Location 1

Entry	Entry Name	Extractable Sugar per Ton	Extractable Sugar per Acre	Gross Sugar per Acre	Tons per Acre	Percent Sugar	Extractable Sugar Percent	Percent Purity	Brei N (ppm)	Percent Tare	Percent* Emergence	Final Stand** Beets/100'	Ave. Mildew Rating (1-9)***	Percent Bolters[#]	Percent Rot[##]
1	BTS 5460	292.3	20,678.1	24,462.9	70.4	17.3	14.6	90.5	25.1	1.4	60.0	238.2	7.8	0.1	0.2
2	BTS 5678	294.3	20,981.1	24,687.5	71.6	17.3	14.7	91.0	29.6	1.1	55.7	239.1	7.9	0.0	0.1
3	BTS 511N	291.5	20,192.6	24,278.7	67.2	17.6	14.6	89.4	23.2	1.5	47.6	239.0	5.2	0.0	0.6
4	BTS 5255	288.3	20,239.8	24,116.7	69.9	17.2	14.4	90.0	21.9	0.8	48.2	238.9	7.0	0.0	0.2
5	BTS 5309	307.0	19,248.5	22,599.4	62.4	18.0	15.4	91.0	31.5	1.5	50.4	233.5	7.7	0.1	0.2
6	BTS 5317	284.0	18,937.8	22,557.7	67.0	16.9	14.2	90.2	25.4	0.9	56.1	238.1	7.7	0.0	0.2
7	BTS 5350	288.4	19,463.9	23,201.4	66.9	17.2	14.4	90.1	33.2	1.4	50.0	235.2	6.4	0.0	0.3
8	BTS 5386	307.7	20,793.9	24,361.3	68.0	18.1	15.4	91.0	26.6	1.5	53.3	237.3	7.7	0.3	0.1
9	BTS 539N	305.9	19,221.9	22,701.4	62.4	18.0	15.3	90.6	29.6	1.0	45.6	234.1	5.9	0.0	0.4
10	SV 1915	302.8	20,478.1	24,060.1	67.5	17.8	15.1	90.9	24.0	1.1	48.8	237.9	5.1	0.4	0.0
11	SV 1927	296.0	19,759.5	23,432.1	66.3	17.6	14.8	90.2	25.3	0.8	45.8	232.8	5.9	1.6	0.1
12	SV 1934N	307.3	17,908.4	21,264.1	57.6	18.3	15.4	90.1	18.0	0.8	57.6	239.4	4.5	0.5	0.5
	Trial mean	297.1	19,825.3	23,476.9	66.4	17.6	14.9	90.4	26.1	1.1	51.6	236.9	6.5	0.3	0.2
	Residual	61.7	1,440,318.2	1,910,780.9	13.9	0.1	0.2	0.5	44.4	0.2	35.9	58.9	0.2	0.1	0.3
	CV (%)	2.4	5.1	5.0	4.7	1.8	2.4	0.7	23.1	34.2	10.0	3.0	5.6	143.0	199.4
	LSD (0.05)	7.7	1176.1	1354.7	3.7	0.4	0.4	0.7	6.5	0.4	5.9	7.5	0.4	0.3	0.5
	Reps	8	8	8	8	8	8	8	8	8	8	8	8	8	8

*Emergence counts taken prior to thinning and converted to a percent.
**Final stand counts taken after thinning and converted to beets per 100' of row.
*** Mildew ratings were taken on May 9, May 19, and May 30 by Joaquin Santiago on a 1-9 scale. 1= no disease and 9= fully covered in powdery mildew. Rating shown is an average of the three rating dates.
[#] Bolters were counted before harvest and converted to a percent of the total beets per plot.
[##] Beets with rot were counted prior to harvest and converted to a percent of the total beets per plot.

Cooperator: Dan Walker
Plant Date: October 13, 2022
Harvest Date: July 18, 2023
Plot size: 2 row, 30" rows.
Experimental Design: RCBD. Analyzed with spatial analysis.

2022-2023 Imperial Valley Late Harvest Official Variety Trial Results - Location 2

Sugar Beet Cyst Nematode affected trial site

Entry	Entry Name	Extractable Sugar per Ton	Extractable Sugar per Acre	Gross Sugar per Acre	Tons per Acre	Percent Sugar	Extractable Sugar Percent	Percent Purity	Brei N (ppm)	Percent Tare	Percent* Emergence	Final Stand** Beets/100'	Percent[#] Bolters	Canopy Wilt[##] Rating (6/15/23)	Percent Rot
1	BTS 5460	294.3	19,083.2	22,885.5	64.8	17.7	14.7	89.5	36.6	1.6	69.4	240.2	0.1	3.4	0.0
2	BTS 5678	297.3	19,324.7	23,113.9	65.2	17.7	14.9	89.9	37.4	1.5	65.0	239.7	0.0	3.9	0.0
3	BTS 511N	289.7	19,953.6	23,626.8	68.7	17.2	14.5	90.6	31.1	2.2	58.5	240.2	0.0	1.6	0.0
4	BTS 5255	299.0	19,538.2	23,395.4	65.3	18.0	14.9	89.7	31.7	1.5	59.9	241.1	0.0	3.6	0.0
5	BTS 5309	290.1	18,338.4	22,086.9	62.9	17.4	14.5	89.4	29.8	1.1	66.2	239.1	0.2	3.1	0.0
6	BTS 5317	297.0	18,925.1	22,742.7	63.9	17.8	14.8	89.4	29.4	1.4	68.7	240.3	0.0	3.5	0.0
7	BTS 5350	292.0	19,352.8	23,303.7	66.0	17.6	14.6	89.2	37.6	1.2	60.5	237.8	0.0	3.9	0.0
8	BTS 5386	295.9	18,694.3	22,457.6	62.6	17.8	14.8	89.3	71.9	1.5	62.9	240.4	0.1	4.1	0.0
9	BTS 539N	298.8	20,139.4	23,837.8	66.7	17.7	15.0	90.6	28.4	1.2	63.2	242.0	0.0	2.1	0.0
10	SV 1915	291.9	17,613.7	21,310.5	60.0	17.7	14.6	88.9	27.5	1.1	62.2	239.5	0.2	4.3	0.0
11	SV 1927	294.4	18,820.1	22,916.6	64.2	17.9	14.7	88.7	49.4	1.1	63.9	240.2	3.0	4.4	0.0
12	SV 1934N	302.4	17,966.0	21,461.8	59.9	18.0	15.1	89.9	12.0	1.4	72.1	242.3	0.5	2.0	0.0
	Trial mean	295.2	18,979.1	22,761.6	64.2	17.7	14.8	89.6	35.2	1.4	64.4	240.2	0.3	3.3	
	Residual	79.2	959,828.2	1,151,600.2	8.5	0.2	0.2	0.8	155.1	0.3	18.9	5.6	0.1	0.3	
	CV (%)	2.6	4.6	4.1	4.0	2.2	2.6	0.9	31.1	33.8	6.0	0.8	144.7	13.7	
	LSD (0.05)	8.7	960.1	1,051.7	2.9	0.4	0.4	0.9	12.2	0.5	4.3	2.3	0.3	0.5	
	Reps	8	8	8	8	8	8	8	8	8	8	8	8	8	

*Emergence counts taken prior to thinning and converted to a percent.

**Final stand counts taken after thinning and converted to beets per 100' of row.

[#] Bolters counted before harvest and converted to a percent of total beets per plot.

[##] Canopy wilt rating taken before harvest on a 1-5 scale. 1 = completely upright canopy, and 5 = completely wilted canopy. Rating taken by Joaquin Santiago on June 15.

Cooperator: Steve Veysey
Plant Date: October 21, 2022
Harvest Date: June 20, 2023
Plot size: 2 row, 30" rows.
Experimental Design: RCBD. Analyzed with spatial analysis.

2023 BSDF Rhizomania Nursery Results - Imperial Valley OVT

Cooperator: Dr. Carl Strausbaugh

USDA/ARS - Kimberly Idaho

Entry[z]	Variety	Foliar rating (% susceptible)[y]	Root rating[x]	Sucrose content (%)	Nitrate (ppm)	Conductivity (mmhos)	Root yield (tons/A)	ERS (lb/A)[w]
7	BTS 5678	0 e	1.8 g	15.45 b	233	0.81	48.76 a	12,643 a
8	BTS 511N	1 de	2.0 f	16.51 a	159	0.72	44.16 b	12,441 a
6	BTS 5460	0 e	2.2 ef	15.91 ab	162	0.72	41.13 c	11,152 b
9	BTS 5255	1 de	2.2 ef	16.17 ab	115	0.76	40.39 c	11,059 b
2	SV 1927	2 cd	2.3 de	15.36 b	129	0.74	38.74 cd	10,098 c
1	SV 1915	4 bc	2.5 c	15.37 b	109	0.69	35.50 e	9,333 cd
5	SV 911	4 b	2.3 de	14.19 cd	118	0.78	36.72 de	8,742 de
3	SV 602	4 bc	2.4 cd	13.56 cd	184	0.79	35.28 e	7,989 e
4	SV 983	0 e	3.2 b	14.30 c	144	0.68	21.31 f	5,172 f
Check	Susceptible Check	100 a	4.0 a	13.39 d	104	0.9	15.85 g	3,478 g
Mean		12	2.5	15.02	146	0.76	35.78	9,211
P > F[v]		<0.0001	<0.0001	<0.0001	0.0848	0.0644	<0.0001	<0.0001
LSD		2	0.2	0.85	NS	NS	2.95	824

[z] BTS 4D20 was included as the BNYVV susceptible check cultivar.

[y] Foliar rating = percentage of foliage with rhizomania symptoms (narrow yellow upright leaves).

[x] Root rating using a scale of 0-9 (0 = healthy and 9 = dead; Plant Disease 93:632-638); $\geq$ 3 would be considered susceptible).

[w] Estimated recoverable sucrose (ERS) = extraction x 0.01 x gross sucrose where extraction
= 250 + [1255.2 x (conductivity -15000) x (percent sucrose - 6185)]/(percent sucrose x [98.66 - (7.845 x conductivity)]).

[v] *P > F* was the probability associated with the F value. Within each variable, means followed by the same letter did not differ significantly based on Fisher's protected least significant difference (LSD; α = 0.05). NS = not significant.