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Chile pepper variety evaluation and profitability analysis at three farms in Minnesota and Wisconsin, 2022

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Latino fresh market vegetable farmers in Minnesota and Wisconsin are interested in growing hot peppers for local markets, both for fresh and dried pepper sales. This variety trial is the third and final trial of a 3 year project. We trialed 14 varieties of peppers representing jalapeño, serrano, habanero, poblano, and “other” types. The varieties included the top varieties from 2020 and 2021, alongside new varieties. We measured yield, fruit size, and Scoville heat units. In addition to the variety trial, we conducted an enterprise analysis to determine the profitability of hot pepper production in the Upper Midwest.

Materials and Methods

Variety trial

The trial was conducted at three sites: Agua Gorda Farm in Long Prairie, Minnesota, Cala Farm in Turtle Lake, Wisconsin, and G&B Gardens in Morris, Minnesota. At all three sites, the trial was set up as a randomized complete block design (4 replications in Turtle Lake, 3 in Morris and Long Prairie). All peppers were grown outdoors, not in high tunnels. Plots were 12 feet long on 3-foot-wide beds (5 feet on center, including walking paths). Plants were transplanted by hand into two rows per plot with 15 inches between plants. At Agua Gorda and Cala Farms, black plastic was used for weed management; at G&B Gardens, beds were covered with straw mulch. Site-specific soil information is included in Table 1. Plants were not staked at any of the three locations.

All transplants for the trial were started in the greenhouse at Cala Farm on March 3 using Cowsmo green potting soil, with an additional 0.5 pounds of Sustane 4-6-4 fertilizer added to each 1.5 cubic yard bulk tote. Plants were started in 72 cell trays and up potted to 50 cell trays on May 3. Transplanting occurred on 31 May (Turtle Lake), 1 June (Morris) and 2 June (Long Prairie).

Growers made their own nutrient management decisions, and so fertilization rates varied considerably between sites. Weeds were managed manually at all sites, and no insecticides or fungicides were needed. At all sites, drip irrigation was applied as needed.

At the time of transplanting, five plants per plot were flagged. Three distinct pepper harvests took place at Cala Farm, and four took place at Agua Gorda Farm. G&B Gardens relied primarily on direct-to-consumer sales in the community, and so they harvested their plots 1-2 times weekly throughout the summer. Jalapeño, Serrano, and Poblano peppers were harvested green; Habaneros and “others” (Ghost and Dorset Naga peppers) were harvested orange or red. At each of the harvest dates, all ripe fruit from the marked plants per plot were harvested, counted, weighed, and any unmarketable fruit was noted. This yield data was used to determine earliness, ripening uniformity, and marketable yield (number of fruit as well as weight).

We used the ChilliPot system to measure scoville heat units of each variety from G&B Gardens and verified the results with HPLC analysis from Southwest Bio-Labs (Las Cruces, NM). A detailed description of these methods is outlined in our 2020 pepper variety trial report (Rohwer et al., 2021).

Enterprise analysis

Each of the growers tracked yield and labor inputs as part of the production trails and shared their experience with marketing the peppers, including prices and outlets. This included recording the amount of time required for a variety of activities such as transplant production, bed preparation, planting, weeding, harvesting, and clean-up. The Extension team recorded input costs, including fertilizer, mulch, drip tape, and transplants. Production and labor costs and prices varied between the three growers. This report attempts to generalize their collective experience to inform the commercial vegetable community about general returns to hot peppers.

Growers participating in the trials sold their pepper through a range of outlets, including food hubs, food manufacturers, Mexican restaurants, Mexican grocery stores, and direct-to-consumer, especially Latino families who purchase large amounts of hot peppers directly from the farmers. In total, the three farmers sold through 10 outlets and received a range of prices by pepper type.

We generated separate enterprise analyses for jalapeño, serrano, and habanero peppers based on the experience of the three growers using their average yield, price, labor, and production measures. The jalapeño data is the most reliable because all three farmers grew and sold jalapeño peppers.

Results and Discussion

Variety trial

In Turtle Lake, growing degree day accumulation was above average for the duration of the growing season, with 200 GDD above the 30-year average by the end of the growing season (Figure 1). Long Prairie conditions remained relatively normal. GDD accumulation hovered around the 30-year average, dipping slightly below normal when harvest began and ending above normal. Conditions in Morris began as average at the time of transplanting but quickly dropped below normal, with GDD accumulation around 100 GDD below normal at the beginning and end of the harvest period (bolded in Figure 1). From planting to harvest, it rained 15.5 inches in Long Prairie, 12.9 inches in Turtle Lake, and 6.5 inches in Morris.

Jalapeños

Yields: Jalapeño yields were comparable across the three varieties but not totally consistent across sites (Figure 2). PS11435807 had the lowest yields in terms of pounds per plant in Morris and Long Prairie and had similar yields to the other two varieties in Turtle Lake. Both PS807 and PS810 produced larger peppers than El Jefe. However, the extent of these differences varied from site to site, with the most notable size differences in Long Prairie. The growers noted that these jalapeños were larger than what many customers expected, but people were interested in purchasing them, particularly for stuffing. El Jefe was more like a standard jalapeño that one could find in a supermarket in terms of size and shape. Jalafuego is not reported because some of the flats containing Jalafuego peppers were mislabeled, and we were not confident that all the peppers in the Jalafuego plots were indeed the correct variety. However, Jalafuego was also considered by the growers to be a standard jalapeño in terms of size and shape.

Earliness: At all three sites, the three jalapeño varieties were consistent with earliness and harvest patterns over time. No variety was significantly earlier or later than another (Figure 3).

Spiciness: Scoville units, as measured by the Chillipot and HPLC, were consistent and substantially lower than the habanero or ghost peppers. While El Jefe and Jalafuego had more variability in spice level than PS11435807, all three varieties were similar (Figure 4).

Serranos

Yield: Serranos were only grown at one location in 2022. Our 2020 and 2021 trials identified high-performing serranos, but the growers in Turtle Lake and Long Prairie struggled to find sufficient markets for them, so they dropped them in 2022. At the Morris location, Sandoval produced more pounds per plant than Altiplano, Devil, or Impala and produced average-sized serrano peppers (slightly smaller than Altiplano, slightly larger than Devil and Impala) (Figure 2). Altiplano lagged behind the other three in terms of both the number of peppers and pounds per plant.

Earliness: While there were substantial differences in yields for serrano peppers, earliness was consistent for Devil, Impala, and Sandoval (Figure 5). Serrano Altiplano was a late producer, with production picking up around 100 days after transplant, compared to 80 days after transplant for the other varieties.

Habaneros

Yield: Four varieties of habaneros were trialed at the Morris and Turtle Lake farms: Caribbean red, Helios, Orange, and Primero Red. Caribbean Red, Helios, and Primero Red had nearly identical yields on a weight basis, with Orange just slightly behind. Helios and Orange (the two orange habaneros) produced slightly smaller peppers than Caribbean Red and Primero Red.

Earliness: Orange and Caribbean red were slightly later than Helios and Primero Red. Production began in earnest around 105 days with Orange and Caribbean red compared to closer to 95 days for Helios and Primero Red.

Spiciness: Scoville measurements varied across habaneros. Primero red had the lowest scoville ratings, both with the Chillipot system and HPLC. The other three varieties had more variability in Scoville ratings, but Caribbean Red was the hottest variety, and Orange and Helios fell in the middle. Scoville measured by the Chillipot seemed to be more variable than measured by HPLC but also closer to what might be expected from habaneros.

Other peppers

Yield: The farmers involved in the trial were interested in peppers with high capsaicin concentrations to add to salsas and chili flakes, so Dorset Naga and Ghost peppers were included in the trial. Dorset Naga had poor germination, so there were only enough plants to trial it at one farm. However, the plants never produced fruit. Ghost pepper yields were lower than habanero pepper yields, with less than half the yield (by weight) of the top three producing habanero varieties.

Earliness: Ghost peppers were similarly late to the habaneros, with production beginning in earnest around just over 100 days.

Spiciness: Ghost was by far the spiciest pepper, with Scoville units 2 times higher than the average habanero according to our Chillipot and 6 times higher according to the HPLC.

Enterprise analysis

- **Prices ranged across market types.** Like with any product, some customers are willing to pay more than others. Farmers received between \$1.75 and \$3.50 per pound for Jalapeño peppers, \$1.65 and \$2.80 for Serrano peppers, and \$3.00 and \$9.00 for Habanero peppers. We used a reasonable midpoint for the analysis to generalize the returns to the crop enterprise.
- **Harvest labor impacts return.** We found that the time to harvest a pound of Habaneros took approximately three times longer than Jalapeños, with Serranos taking about 50% longer than Jalapeños. The price premium for Habaneros does (or should) reflect this difference. Overall labor greatly impacts profitability, accounting for 70-75% of all costs valued at a \$15/hour labor rate. Serranos noticeably underperformed since the time to pick was greater than Jalapeños, and both their yield and price were lower than Jalapeños.
- **Weeding labor varied across the three farms, but other expenses were consistent.** The time spent per 100-foot bed (2 rows that are 100 feet long in a single bed) of peppers for transplanting, mulching, and clean up was very consistent, but the time spent in weeding varied greatly between 1.25 and 4 hours for the season. The lowest and highest amounts of time were spent on plastic mulch, with the remainder on straw. All told, the growers reported spending 7.3 hours on production labor on average for 6-800 bed feet of hot peppers.

Table 2 reports all revenue and expenses for each type of pepper based on average yield and production costs from trials and the marketing experiences of trial participants. We found that overall, Jalapeños had a 56% gross margin with an average return of \$141 per 100-foot bed feet. Serranos had a 34% gross margin with an average return of \$66 per 100-foot bed feet, and Habaneros had a 47% or -5% gross margin with a return of \$131 or -\$7 per 100-foot bed depending on price. There was a large range of prices paid for Habaneros, so we estimated returns at \$6 and \$3 average price per pound.

Overhead costs

Net revenue in Table 2 only reflects earnings after subtracting direct production costs for hot peppers. Any farm operation will also have overhead costs encompassing a wide range of cost categories, including taxes, rent or mortgage costs, depreciation, and insurance. For mixed vegetable operations, these costs are allocated across a range of crops, and this enterprise is no exception.

Based on our most recent assorted vegetable benchmarking data from 2015 (Pesch et al, 2015), overhead costs averaged \$30.06 per 100-foot bed or \$2,618 per acre adjusted for inflation. Albeit old data, this remains the best and most current estimate of total overhead costs for commercial vegetable operations in Minnesota. Regardless, farms vary significantly, and any operator ought to take care to use and calculate their own overhead costs.

After incorporating an estimate of overhead expenses, Jalapeño and Habanero peppers at \$6/lb retained a reasonable profit margin at 31 and 25 percent, respectively (Table 3). Serrano peppers are less profitable but still breaking even, primarily due to low pricing based on the experience of project participants.

Hot pepper marketing costs

Another way to examine the overall returns to hot pepper is to estimate and incorporate the direct marketing costs for the hot pepper enterprise. Any farmer growing and selling hot peppers will have marketing costs to bring peppers to market including transportation, selling time, and post-harvest packaging directly related to the enterprise.

Marketing costs for a single vegetable crop are difficult to generalize because any crop is typically part of a mix of vegetables sold through an outlet, and any grower has costs often driven by geography. A grower selling through an outlet 100 miles away will have significantly higher marketing costs than a grower selling through an outlet 10 miles away. The project team did not ask growers to track all marketing costs related to their hot pepper sales across the ten outlets.

The scenario below illustrates the impacts of marketing costs on profitability (Table 4). In this scenario, Jalapeño peppers are sold at \$3 per pound in 35-lb bushel cartons to a restaurant that is 30 miles away from the farm. For each delivery, the hot peppers are only 20% of the total sale since the farmer is delivering other vegetables at the same time over eight weeks.

After subtracting the marketing costs in this scenario, the grower has an 87% gross margin. One way to understand this number is that the grower keeps 87 cents of every dollar sale after

subtracting marketing costs. After incorporating production costs and allocating an estimate of overhead costs, the final profit margin stands at 18%.

Conclusions

This data concludes the final year of a three-year pepper trial. Our results reinforce the value of variety trials that include on-farm research sites, as growers provide valuable qualitative feedback that is not always reflected in yield or other quantitative data. Despite substantial variation between sites, we identified the following varieties as well-suited to the needs of Minnesota growers:

- **Jalapeño:** El Jefe, PS11435807, and PS11435810 were all consistently high-yielding varieties across all three sites.
- **Serrano:** In 2020, Altiplano was an average-performing Serrano. We trialed three new varieties alongside it this year, and all three performed slightly better and produced slightly earlier. Devil, Impala, and Sandoval are all well-adapted varieties for the Upper Midwest.
- **Habanero:** Caribbean Red, Helios, and Primero Red were the highest-yielding varieties. Of the three, Helios and Primero Red are earlier varieties (which might matter more in a season with a shorter fall). Primero Red had a lower scoville rating than Helios. Therefore, if the goal is a high-yielding, early, high-heat variety, Helios may be the best choice.
- Peppers bred for extreme heat, like Ghost peppers and Dorset Naga may not be well suited to the climate of the upper Midwest. The extra heat in the peppers comes at the expense of significant yield reductions compared to other types of peppers, and in the case of Dorset Naga, plants did not produce at all.

Based on our marketing analysis, we conclude that Jalapeño and Habanero peppers can be profitable for Latino farmers in Minnesota, with an average profit margin of 31% and 25%, respectively, assuming \$3 per pound in sales for Jalapeños and \$6 per pound for Habaneros. Habanero peppers have lower yields and require more labor to harvest, but if growers can find markets that will pay premium prices for them, they remain profitable. Serrano peppers were less profitable due to less demand, lower prices, and more labor relative to jalapeños.

Literature cited

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Table 1. Soil properties and amendments used at the four sites used in this study, with plant and row spacing details.

Site	Lat. & Lon.	Soil type	pH	% OM	Soil test P (Bray 1, ppm)	Soil test K (ppm)	Fertilizer added (per acre)
Agua Gorda Farm Cooperative, Long Prairie, MN	45.9747° N, 94.8656° W	Duelm Loamy Sand	7.2	3.1	41	72	1 ounce Sustane 4-6-4 at the base of each plant at planting and again 3 weeks later (1360 pounds per acre total)
Cala Farm, Turtle Lake, WI	45.3944° N, 92.1424° W	Anigon Silt Loam and Crystal Lake Silt Loam	6.4	2.3	188	227	2 tons/acre poultry manure (field was fallow with sheep grazing the year prior)
G&B Gardens, Morris, MN	45.5871° N 95.9275° W	Udorthents loamy-urban land complex	7.3	5.9	61	300+	2-3 inches of used dairy cow bedding (straw mixed with manure) was applied across the field the previous fall.

Table 2. Returns to enterprise by the type of hot pepper, estimated per 100' bed with 2 rows of peppers at 15-inch spacing (160 pepper plants per 100-foot bed).

	Jalapeño	Serrano	Habanero	
Sales				
Average price per pound	\$3.00	\$2.50	\$6.00	\$3.00
Lbs/plant	1.32	1.23	0.72	0.72
Estimated Pounds Sold (80% of marketable fruit)	168.96	157.44	92.16	92.16
Revenue	\$506.88	\$393.60	\$552.96	\$276.48
Direct Expenses				
Transplants	\$65.32	\$65.32	\$65.32	\$65.32
Fertilizers	\$19.53	\$19.53	\$19.53	\$19.53
Pesticides/herbicides	\$-	\$-	\$-	\$-
Black plastic per 100' row	\$5.51	\$5.51	\$5.51	\$5.51
Irrigation - drip cost per 100'	\$4.80	\$4.80	\$4.80	\$4.80
Total Annual Direct Expenses	\$95.15	\$95.15	\$95.15	\$95.15
Labor Costs at \$15/hour				
Bed Preparation	\$6.00	\$6.00	\$6.00	\$6.00
Planting/Transplanting	\$30.00	\$30.00	\$30.00	\$30.00
Weeding and Maintenance	\$78.00	\$78.00	\$78.00	\$78.00
Mulching	\$6.00	\$6.00	\$6.00	\$6.00
Harvest*	\$99.00	\$135.00	\$165.00	\$165.00
Fall clean-up	\$6.00	\$6.00	\$6.00	\$6.00
Total Annual Expenses	\$225.00	\$261.00	\$291.00	\$291.00
Revenue				
Total Direct Costs	\$320.15	\$356.15	\$386.15	\$386.15
Return over Direct Costs	\$140.94	\$66.30	\$130.98	\$(14.52)
Gross Margin	56%	34%	47%	-5%
Cost per pound sold	\$1.89	\$2.26	\$4.19	\$4.19

Table 3. Net revenue after factoring in overhead expenses.

	Jalapeño	Serrano	Habanero	Habanero @ \$3/lb
Overhead Expenses per 100-bed feet	\$30.06	\$30.06	\$30.06	\$30.06
Overhead + Direct Expenses	\$350.21	\$386.21	\$416.21	\$416.21
Net Revenue				
Revenue - total costs	\$156.67	\$7.39	\$136.75	\$(139.73)
Profit Margin	31%	2%	25%	-\$51

Table 4. Sample marketing cost budget for Jalapeño peppers.

	Lbs/unit	Price/unit	Units sold per week	Revenue per week	Total per 8-week Season
Revenue (35 lb bushel)	35	\$105.00	1	\$105.00	\$840.00
Marketing Costs	No. of units	Cost/unit	Pepper % of Sales	Pepper Cost/Week	Total per 8-week Season
Post-harvest material	1	\$2.24		\$2.24	\$17.92
Labor - Post-harvest handling	1	\$15.00	20%	\$3.00	\$24.00
Labor - Sales/communication	0.5	\$15.00	20%	\$1.50	\$12.00
Labor - Drive time	1.0	\$15.00	20%	\$3.00	\$24.00
Mileage	30	\$0.63	20%	\$3.75	\$30.00
Total				\$13.49	\$107.92
Net Return Marketing Costs					\$732.08
Gross margin					87%
Net Revenue	Per week	Per season			
Revenue	\$105.00	\$840.00			
Production costs (\$1.89/lb)	\$66.15	\$529.20			
Marketing costs	\$13.49	\$107.92			
Overhead costs (\$0.18/lb)	\$6.30	\$50.40			
Total costs	\$85.94	\$687.52			
Net Revenue (revenue-total costs)	\$19.06	\$152.48			
Profit margin	18%	18%			

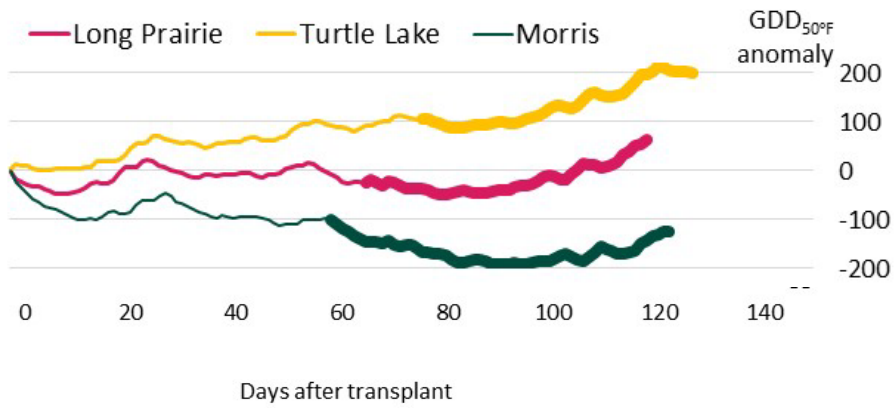


Figure 1. Growing degree day (GDD) accumulation at each farm over the course of the 2022 growing season. The 0 line in the center represents the 30-year average GDD accumulation. The bold portion of each line represents the harvest period.

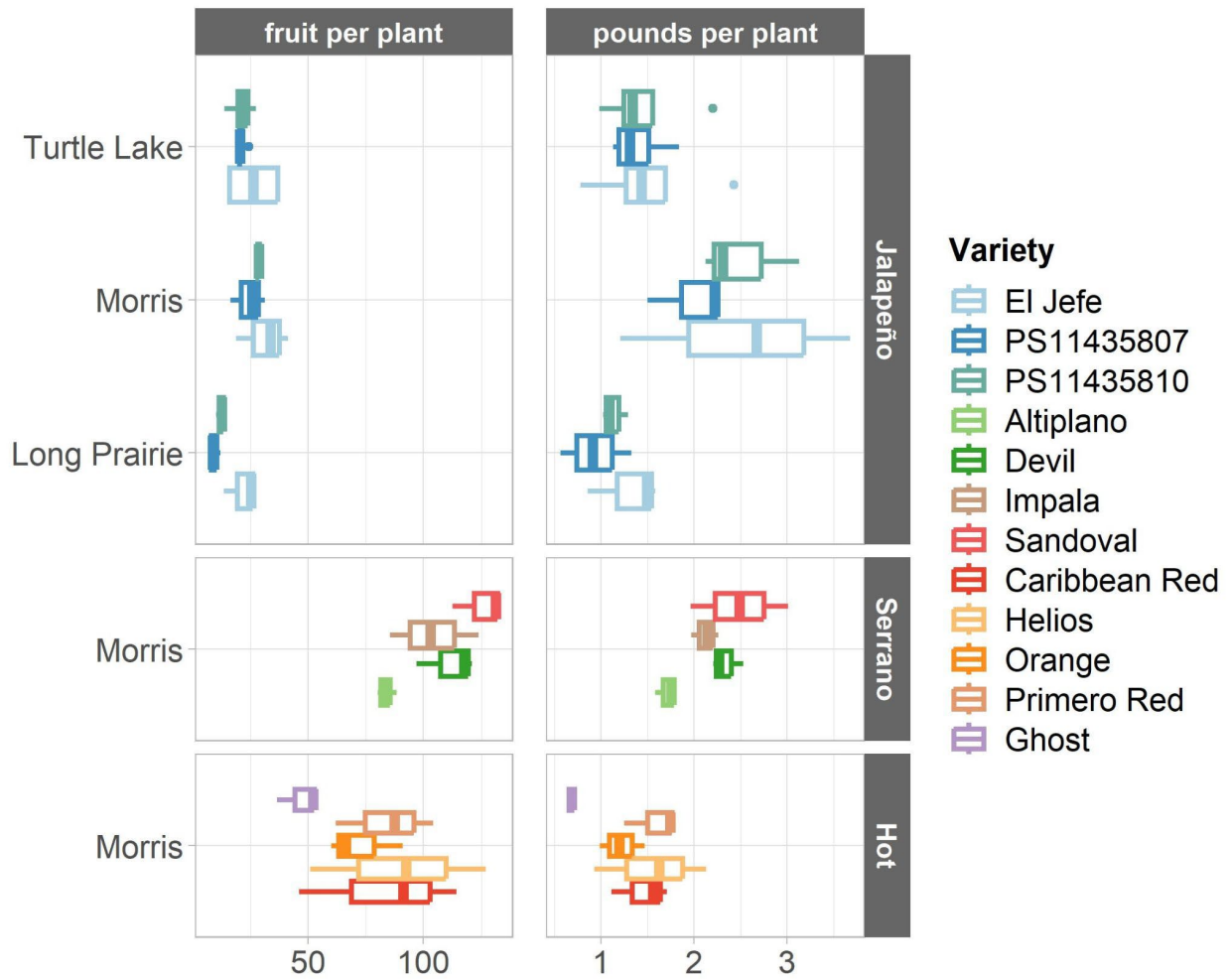


Figure 2. Pepper yields at three sites in terms of fruit per plant and pounds per plant. Box plots for each variety represent the mean, interquartile range, standard deviation, and outliers for each variety at each site.

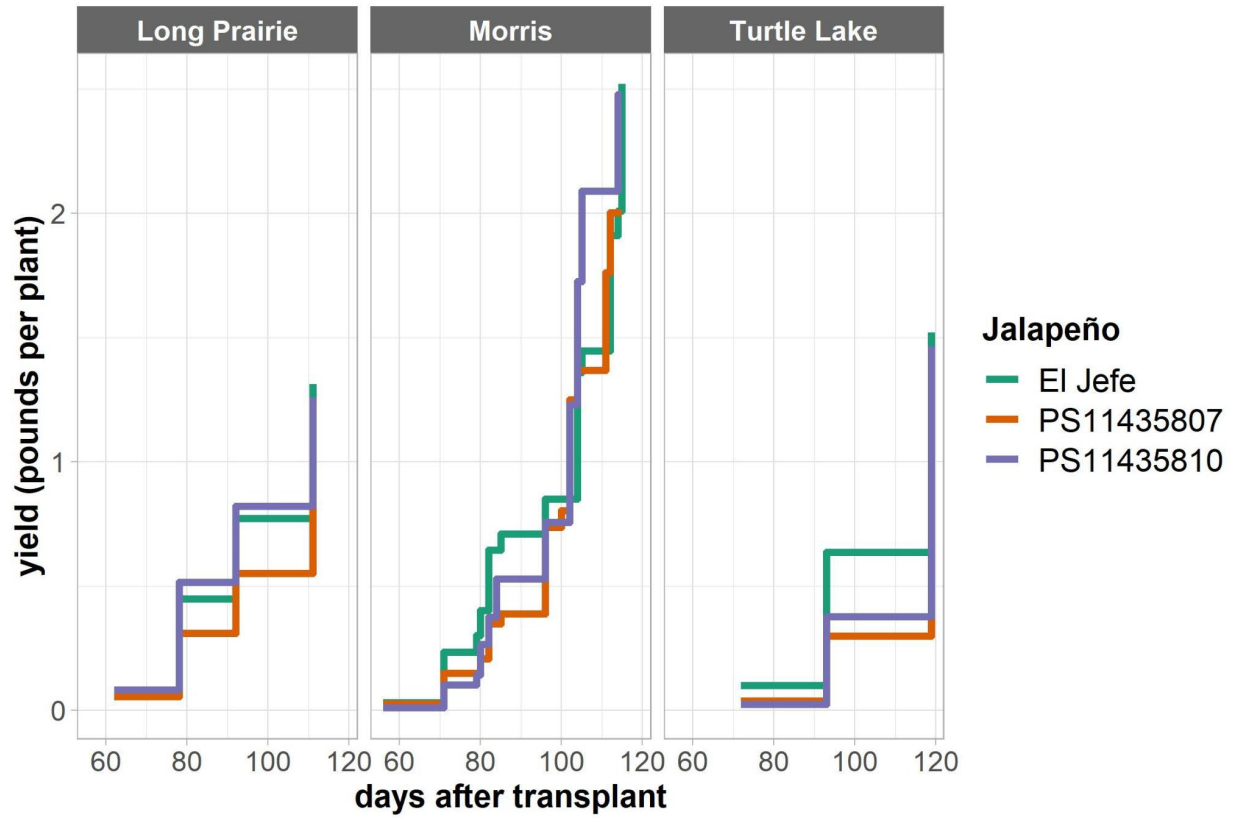


Figure 3. Harvest graphs show cumulative harvest in pounds over time for each jalapeño variety.

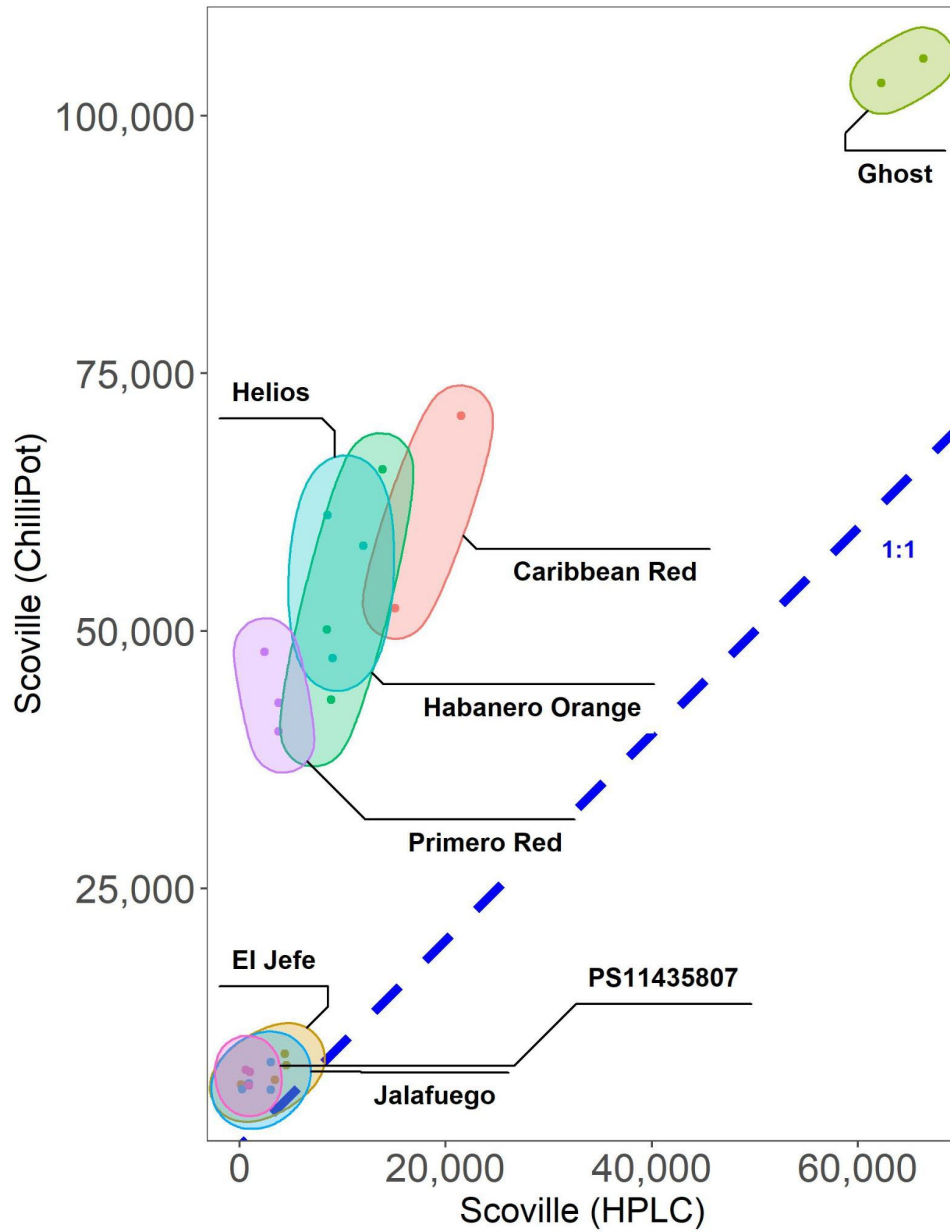


Figure 4. Scoville readings for each pepper variety, as determined by the ChilliPot device (y-axis) and high-performance liquid chromatography (HPLC) (x-axis). The blue 1:1 dashed line represents an equal measurement from both devices; in nearly every case, the ChilliPot system provided higher Scoville readings than the HPLC.

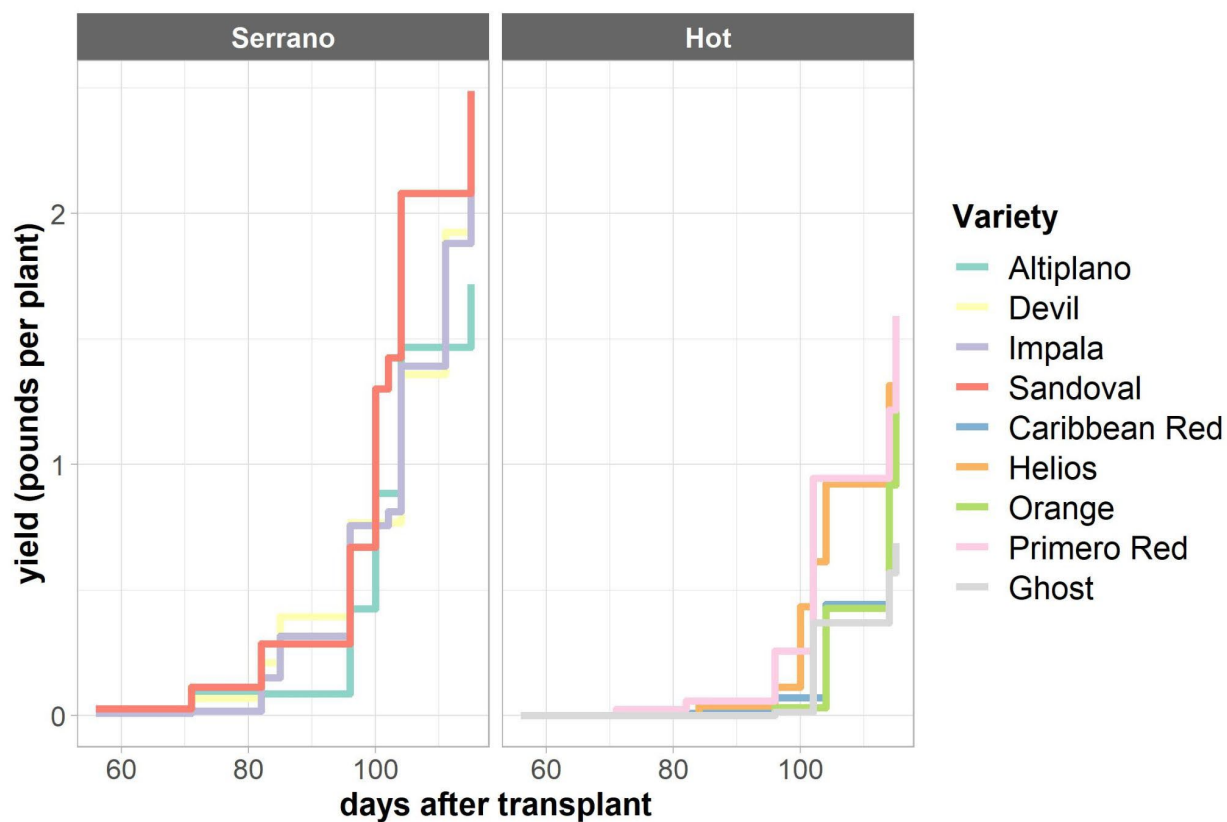


Figure 5. Harvest graphs show cumulative harvest in pounds over time for each serrano, habanero, and ghost variety.