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# Optimal Cultural Practices for Processed Sweetpotato Products

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# OPTIMAL CULTURAL PRACTICES FOR PROCESSED SWEETPOTATO PRODUCTS

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## ABSTRACT

As the sweetpotato industry moves towards more processed products, there is a need to develop strategies in which to optimize total yield and reduce costs. Unlike the fresh market product, desirable processing roots are larger in size and overall tonnage is preferred over aesthetic appeal. Plant spacing and row width along with planting dates and harvest dates are believed to affect the size and tonnage of sweetpotato roots. The Beauregard and Evangeline varieties were planted at an early planting date (June 1) and a late planting date (July 1) on 38 and 42 inch row spacing. Harvests were at ~125 and ~140 days after planting. The delay in harvest increased yield of all grade categories except for U.S. No.1. The first planting date was also superior to the second planting date. Row width had a marginal effect. Only the canner grade was significantly higher for the 42 inch width in 2010 which caused the total yield category to be significantly higher. Plant spacing was less important and demonstrated that lower planting densities are possible. Furthermore, results demonstrated that a delayed harvest does not reduce the U.S. No.1 yield and only increases total yield.

Storage root quality must be maintained all the while reducing costs. Consumers demand processed sweetpotato products that taste as good as the fresh market product. Many times roots for processing are not cured and therefore do not gain in sugar contents and visual appeal. Roots could possibly be left in the field after de-vining and before harvest in the hot, humid times of the year which is similar to the curing room environment. Beauregard and Evangeline varieties were de-vined in successive days from day 0 to day 4 early in the harvest season (~September 1) and late in the harvest season (~November 1). Raw and French fry roots were analyzed for sucrose, fructose, glucose, maltose, and total sugar content. As the de-vining period was extended, few treatments showed trends toward higher sugar contents. Significant differences did

exist but they were not consistent enough to recommend a reliable field curing schedule that would increase sugar contents.

## CHAPTER 1: INTRODUCTION

The sweetpotato [*Ipomoea batatas ( L).* Lam] is a member of the Morning Glory Family, *Convulvaceae.* The United States harvested over 134,000 acres (54,229 hectares) of sweetpotatoes in 2011. The top five sweetpotato producing states in that year, in order form greatest to least, are North Carolina, Mississippi, California, Louisiana, and Arkansas ("Crop production 2011 summary," 2012). Though the sweetpotato is a perennial and is indeterminate, it is grown for consumption as an annual. It is a very valuable crop, boasting one of the highest gross values, on a per acre basis, of all vegetable crops grown in the United States. It also has one of the highest costs per acre (Peet, 2001).

The sweetpotato is sub-tropical in origin and likely came from tropical parts of America (Loebenstein & Thottappilly, 2009). Even though commercial production is limited to the South and western United States, it has been successfully grown in temperate areas. Sweetpotatoes are technically the storage roots of the plant and are the only part of the plant consumed in the United States. In many other countries, the leaves are consumed also. The flesh color varies from orange, to purple, to white, to yellow. The orange fleshed varieties are most popular in the United States. The skin color varies greatly as well. The color of the skin can be brown, white, red, or red-orange. The sweetpotatoes that are grown in mass in the southern U.S. are all mostly grown to be sweet tasting, orange fleshed dessert varieties. Starchy, white fleshed varieties are more common in other areas of the world such as East Africa, Asia, and the Caribbean (Jackson & Bohac, 2006). Production in the tropics represents the bulk of the world's production and this acreage contributes to making sweetpotato the seventh most cultivated crop in the world (Woolfe, 1992). The sweetpotato is not to be confused with the "yam," which is a crop that is grown outside of the United States. Sweetpotatoes are sometimes called "yams," but for marketing purposes only.  The yam is of a totally different genus (*Dioscorea*) and family (*Dioscoreaceae*) than that of the sweetpotato (Peet, 2001).

As shoppers have become more aware of the health benefits of sweetpotato, the demand for the crop is on the rise.  U.S. sweetpotato consumption per capita was estimated at 5.7 pounds (2.59 kg) in 2010, up some 35% from 2000 (Strang and Wright, 2010).  In order to make the crop more widely available, there is new emphasis in the sweetpotato industry to shift a higher percentage of roots toward a processed product.  With the high labor costs and high demand for sweetpotatoes there is a need for a more mechanized, cost efficient method for harvest and storage.  The bulk harvest system, similar to the system used in the harvest of potato (*Solanum tuberosum L.*), could have utility in sweetpotato production.  There would be much less labor involved which is the highest cost (30% of total costs) a producer faces (Hinson, 2011).  The product can be harvested and stored by never being touched by a human hand.  This would also benefit the quality of the roots by minimizing handling and would end the need for pallet boxes which are expensive to purchase and repair.  Processors do not require the roots to be washed or necessarily be cured before being processed.  Curing does enhance sugar content which enhances taste for the consumer (Picha, 1985). Growers must reduce costs to meet lower processing prices paid for roots.   The obvious solution to make growers who serve the processing sector more successful is to cut out steps in the traditional postharvest handling and storage used in fresh market sweetpotato production to reduce costs.  In order to produce a quality product some method of curing must take place and there must be a protocol developed to optimize yield while moving sweetpotatoes efficiently and cheaply without using the traditional curing process.

The cost of producing sweetpotatoes is very high.  The average cost per acre is close to $3000 (Hinson, 2011).  This cost reflects labor, fuel, chemical application, fertilizer costs, etc.  The quality of the roots is the major deciding factor in what price will be paid for them.  The

U.S. #1 grade receives the highest price for its uniform roots. In changing to a bulk harvest system for processing, these roots do not have to be perfect. The root's appearance is not as significant a factor if it were to be made into fries or baby food. This could help prevent waste of roots that taste the same as more attractive roots, but are discarded because of their shape or size. Table 1.1 shows the economics on 100 acres of sweetpotatoes grown in a bulk harvest system. The price required to make a profit would need to be higher than $0.15 per pound on a slightly less than average year, making 400 bushels per acre. In a good year, making 600 bushels per acre, there would be a profit realized if the price exceeds $0.10 per pound and the grower would potentially come away with a profit (T. Smith, 2011 Personal Communication).

Table 1.1. Revenue estimates for sweetpotato as a function of price and yield.

| **Input cost ($/acre)** | **Yield (bu/acre, lb/acre)** | **Price ($/lb)** | **Total revenue ($/acre)** | **Producer profit margin ($/acre)** |
|---|---|---|---|---|
| 3,000 | 400/20,000 | 0.10 | 2,000 | - 1,100 |
| 3,000 | 400/20,000 | 0.15 | 3,000 | Break even |
| 3,000 | 400/20,000 | 0.20 | 4,000 | 1,000 |
| 3,000 | 600/30,000 | 0.10 | 3,000 | Break even |
| 3,000 | 600/30,000 | 0.15 | 4,500 | 1,500 |
| 3,000 | 600/30,000 | 0.20 | 6,000 | 3,000 |

Table provided by T. Smith, 2011.

One grower is already realizing how a bulk system may serve to increase production and efficiency. In north Louisiana, Thornhill Farms has fabricated a modified harvester, somewhat of a hybrid between traditional harvesters and the bulk harvesters used by the potato industry. The machine has a sizing belt and does not require workers to place certain grades in certain places. The sizing belt simply sends roots smaller than 2.5 inches (6.25 cm) in diameter to one trailer on one side and any greater than 2.5 inches (6.25 cm) in diameter (desirable processing roots) to a trailer on the other side. In years past Thornhill Farms had a crew of 42 workers riding 3 traditional 2 row harvesters with off-loading belts. They traveled at only 0.5 miles per hour (0.83 km/h) and each harvester could only harvest 5 acres (2.02 ha) per day. With this new modified harvester it only requires 12 workers and can move at 2 miles per hour (3.3 km/h). This harvester can harvest up to 25 (10.11 ha) acres per day. The labor cost and increased production has more than paid for the new harvester (Table 1.2). Additional labor costs will be incurred when including the wages for equipment operators. In contrast a true bulk harvester requires 9 workers to drive vehicles and to sort the roots at the edge of the field and this machine can harvest up to 20 (8.09 ha) acres a day. This machine also does not require the vines to be cut before harvest. Cost is a problem for some smaller growers. It requires a tractor with greater than 150 horsepower to operate a two row Lockwood® brand bulk harvester and a tractor with greater than 250 horsepower to operate a four row Lockwood® brand bulk harvester. These tractors are expensive to purchase and, for many growers, a tractor of that size is not useful for other farming needs so they must purchase one instead of being able to pull from their existing inventory. The harvesters themselves cost from $160,000-$200,000. That is large investment that many growers are not capable of making (T. Smith, 2012 Personal Communication).

Table 1.2 Labor cost estimates for various harvest methods.

| **Harvest Method** | **Workers Required** | **Wages ($/hour)** | **Time (hours/ day)** | **Area Harvested(acres/day** | **Labor Cost ($/day)** | **Total Cost ($/acre/)** |
|---|---|---|---|---|---|---|
| Traditional Harvester (2-row) | 42 | 7.25 | 11 | 15 | 3349.50 | 223.30 |
| Modified Harvester | 12 | 7.25 | 11 | 25 | 957.00 | 38.28 |
| Bulk Harvester | 26 | 11.00 | 11 | 20 | 3146.00 | 157.30 |

A new approach to root yield must be taken to make this system successful. In the past, sweetpotatoes have been grown for quality based on a USDA yield grade standards for fresh market purposes. This is not the case using bulk harvest. Most processors take any roots which are not decaying and are greater than 2.5 inches (6.25 cm) in diameter. Any blemishes or crooks are not of concern to the grower. In this case, there could be an emphasis on growing to produce more overall tonnage and having a greater percentage of larger roots such as U.S. No. 1 and Jumbo grades. The grower now strives to achieve the largest percentage of U.S. No. 1 grade roots. Smaller roots and Jumbo are to be minimized. Growers are challenged to time harvests and reduce the number of unwanted roots. Growing roots to optimize larger roots and tonnage should create a larger window of success considering that the roots essentially cannot get too large. There is a need for an examination of different planting and harvest dates to find the best combination to achieve these large roots and greater tonnage.

It is an assumption that the farther apart plants are spaced, the larger the roots will be and the higher the tonnage. Most growers use row widths ranging from 38 to 42 inches to produce sweetpotato in the U.S. The difference if any between various row widths has not been evaluated. Spacing has been evaluated previously; however, spacing has only been evaluated up to 12 inches (Schultheis *et al.*, 1999) or using extreme spacing beyond 15 inches (Mulkey *et al.*, 1994). Other work has looked at spacing in hydroponics (Mortley *et al.*, 1991) or in developing countries where production practices are dissimilar to those used in the U.S. (Aladesanwa and Adigun, 2008). Nitrogen rate and close spacing (< 12 in) has also been investigated (Guertal and Kemble, 1997). Furthermore, plant spacing has not been evaluated along with row width. Notably, as most research in sweetpotato has been directed toward the fresh market sector, no research has been conducted in which the main objective is to optimize total tonnage and large size roots. Research has been conducted that showed that there is a higher probability of achieving more Jumbo roots with a wider spacing due to less competition for water and nutrients (Villordon *et al.*,2011). Many university documents suggest certain plant spacing and row width as "common" (May and Scheuerman) or at the discretion of the grower (Kemble *et al.*, 2006) and support the notion that spacing in general is a nominal variable. No data is available demonstrating a combination of plant spacing and row widths evaluated at different harvest dates in order to optimize tonnage and larger roots. The present research is to identify the importance of planting and harvest dates, plant spacing, and row width on yield.

The curing process is vital to sweetpotato production. Curing is the process where roots are put into storage at 85-90°F (30-32°C) and 90-95% relative humidity for 4 to 10 days. After curing, the temperature is dropped to 60°F (15.6°C) for long term storage, keeping the same relative humidity (Picha, 1986). Curing enhances the eating quality by decreasing the starch content and increasing the sugar content. It also aids in healing any wounds the roots may have sustained during harvest. The healing of these wounds aids in preventing infection. Weight loss through moisture loss is also minimized through curing. The sweetpotatoes that are sold early in the harvest season without curing, called "green" sweetpotatoes; lack the visual appeal, shelf life, and taste of those roots that are properly cured (Boyette *et al.*, 1997). Sweetpotatoes are shown to have a sharp increase in sucrose and total sugar content immediately after the curing process is complete. Fructose and glucose remain constant and maltose is not present in the raw product. Sucrose content has been shown to increase from 6 to 10 grams per 100 grams of total root dry weight after 10 days in a curing environment. Further increases are achieved after 46 weeks in storage at 60°F (15.6°C) and 90-95 % relative humidity (Picha, 1987).

Curing is a major factor in deciding the quality of the roots. Along with the new harvest system it is imperative to tailor the curing process to work best with the system. It is a possible "field curing," which could cut down on handling and storage cost. These practices could prove highly beneficial to growers in the new market that requires a much higher quantity of sweetpotatoes for processing. The sugar content is a determining factor in quality of fries especially. Maltose increases after cooking and is in much higher percentage than other sugars (Picha, 1985). Sweetpotatoes increase in sugar content as roots develop (LaBonte *et al.*, 2000) and it is not yet known if this sugar increase continues after the vines are cut but, before the roots are harvested. If sugars increase after de-vining, it would benefit consumers and the grower. Growers could leave the roots in the ground for a few days to achieve this better tasting product and also eliminate the curing costs.

Delayed harvest after canopy removal has already been proven to increase the skinning tolerance of roots (LaBonte and Wright, 1993). Skinning tolerance and the healing incurred by curing could be related. Healing of roots is a positive attribute of curing just like sugar increases are as well. If healing is associated with increased sugars, then this skinning resistance may have something to do with increased sugars as well.

The objectives are to develop a standard for optimal days to harvest, optimal plant and row spacing, and examine novel means of curing sweetpotatoes. The results of these experiments will hopefully assist in determining protocols to optimize yield, postharvest treatment, and storage methods.

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# CHAPTER 2: OPTIMIZING STORAGE ROOT YIELD IN SWEETPOTATO

## 2.1 Introduction

Consumers have become more aware of the health benefits of sweetpotato and demand is on the rise. In order to make the crop more widely available, there is new emphasis in the sweetpotato industry to shift a higher percentage of roots toward a processed product. With the high labor costs and high demand for sweetpotatoes there is a need for a more mechanized, cost efficient harvest. The bulk harvest system, similar to the system used in the harvest of potato, could have utility in sweetpotato production ("commercial potato production," 2010). There would be much less labor involved which is the highest cost a producer faces accounting for 30% of all expenses (Hinson, 2011). Roots can be harvested and stored by never being touched by a human hand. This would theoretically benefit quality by minimizing handling. Storing in bulk would end the need for pallet boxes which are expensive to purchase and also expensive to repair. In summation, production costs now estimated at $3000 per acre for sweetpotato (Table 2.1) could approach $2000 per acre, the estimated production cost for sweetpotato excluding current labor costs (T. Smith, 2012 Personal Communication).

Sweetpotatoes are grown today to optimize production of U.S. No. 1 grade. There are three grades in which sweetpotatoes are sold: U.S. No. 1, Canner, and Jumbo. Jumbo and Canner roots are secondary grades or No. 2 grades and are not as desirable as the premium U.S. No. 1 grade. U.S. #1 roots are 2 to 3.5 inches (5.1 to 8.9 cm) in diameter and 3 to 9 inches (7.6 to 22.9 cm) long and are straight, uniform roots, free of blemishes. Canner roots are 1 to 2 inches (2.5 to 5.1 cm) in diameter and 2 to 7 inches (5.1 to 17.8 cm) long. Jumbo roots are larger than U.S. No. 1 in diameter, length, or both and without objectionable defects (LaBonte *et al.*, 2008). Processing production changes this equation and targets higher total yield with no regard to U.S. No. 1 grade. In this new bulk system, the Jumbo grade would be the most desirable size.

The equipment used by processors works more efficiently when the larger roots are processed resulting in less waste. Some processors prefer a root that is no smaller than 2.5 inches (6.25 cm) in diameter with no restrictions on the length or degree of blemishing. The root can be processed as long as it is not decaying. This would be beneficial for growers in that they will be able to make use of some of these roots that are not acceptable in the fresh market. Growers also do not have to wash roots prior to shipping them to a processor. Currently no published research shows any data on the optimization of Jumbo roots and/or tonnage or the effect of row spacing and plant spacing on the size and shape of sweetpotato. Harvest date data is also needed to evaluate the best combination to optimize the production of Jumbo roots and/or the most tonnage. The hypothesis is that using a wider row and plant spacing will allow more room for the roots to grow larger and will also minimize competition with other plants. Longer growing periods should also increase the overall tonnage and possibly the root size. Because sweeetpotato is indeterminate and never stops growing this should be advantageous (Woolfe, 1992). Planting dates (early and late) represent another variable. These results could enable researchers to make a recommendation on the row and plant spacings as well as the harvest dates to optimize tonnage and number of Jumbo roots. The present study examines the importance of planting and harvest dates, plant spacing, and row width on yield.

### 2.2 Materials and Methods

Field research was conducted at The Sweet Potato Research Station in Chase, Louisiana in the summers of 2010 and 2011. The plot was split – split plot design. Beauregard and Evangeline sweetpotato cultivars were used to develop production guidelines to optimize tonnage and oversize (Jumbo) roots.

The two varieties were planted in two row plots. Plots of each variety were planted at 12 inch (30.48cm) and 16 inch (40.64cm) plant spacings. The plots were 30 feet (9.1m) long with

10 feet (3m) between plots. These treatments were replicated four times. This experiment was tested on 38 inch (96.52cm) row spacings as well as 42 inch (106.68cm) row spacings. Planting/harvest date combinations were also evaluated. The combinations were early planting (1 June 2010; 7 June 2011)/early harvest (8 October 2010; 11 October 2011), early planting (1 June 2010; 7 June 2011)/late harvest (22 October 2010; 25 October 2011), late planting (30 June 2010; 8 July 2011)/early harvest (5 November 2010; 8 November 2011), and late planting (30 June 2010; 8 July 2011)/late harvest (19 November 2010; 22 November 2011). In 2010 the early planting/early harvest combination was harvested at 129 days after planting, the early planting/late harvest at 143 days, the late planting/early harvest at 129 days, and the late planting/late harvest at 143 days. In 2011 the early planting/early harvest combination was harvested at 126 days after planting, the early planting/late harvest at 140 days, the late planting/early harvest at 123 days, and the late planting/late harvest at 137 days.
The soil type was a Gilbert silt loam and 4-11-11 fertilizer was applied at a rate of 1000 pounds (454.5 kg) per acre. The plot was irrigated just after planting and subsequently at 25-50% field capacity throughout the growing season. Plant stand counts were taken approximately one week to 10 days later. Typical cultural practices were followed throughout the year as recommended by the Southeastern U.S. Vegetable Crop Handbook (Kemble *et al.*, 2012).

One row of each plot was harvested at approximately 125 days after planting and the remaining row was harvested at 140 days after planting. The plots were harvested on their respective dates by chain harvester methods. The roots were laid out on the ground by mechanical harvesting machines then picked up manually, graded, and placed into one of three separate boxes according to USDA grade standards: U.S. No. 1, Canners, and Jumbo grade. Each box was weighed and data recorded. The data was quantified to represent a “per acre” yield basis which is the most popular way yield is represented by U.S. growers.

## 2.3 Results

Data documenting yield of Beauregard and Evangeline varieties were analyzed using PROC GLM at the P=0.05 significance level using Duncan's multiple range test (9.3, SAS Institute, Cary, NC.). Treatments included planting/harvest date combination, variety, plant spacing, and row width.

Yield data was presented as the average yield for the Beauregard and Evangeline varieties combined, except in the case of the analysis of varietal differences, because no varietal interaction existed. Across all other treatments, there were no interactions excluding a harvest date/row width interaction in all grade categories except the Jumbo category in 2010. Data is presented separately for 2010 and 2011 given extreme environmental differences. 2010 was characterized as near ideal conditions with rainfall and moderate temperatures at the right time. The average high temperature for the months of June, July, August, and September was 95.3°F (35.2°C) with a total rainfall of 10.82 inches (27.4 cm) in those months. 2011 was characterized by sufficient rainfall at the wrong times and high temperatures. The average high temperature for the months of June, July, August, and September was also 95.3°F (35.2°C) but there were many days early in the season where the temperatures were over 100°F (37.8°C). The total rainfall was 12.72 inches (32.3 cm) in those months. Consequently 2010 yields were much higher than the 2011 yields.

### 2.3.1 Harvest Date

Harvested roots were categorized based on planting/harvest date combination. The date combinations represent: early planting/early harvest (EE); early planting/late harvest (EL); late planting/early harvest (LE); and late planting/late harvest (LL) in 2010 and 2011. The data presented in Fig. 2.1 and Fig. 2.2 represent average yield for the Beauregard and Evangeline varieties. Overall the yields for each grade category showed similar results across all planting/harvest date combinations.

**2010 Results.** For U.S. No. 1 grade roots, the EL harvest period yielded higher than all other harvest periods but no harvest period was shown to be significantly different (Fig. 2.1). The Ones+Jumbo grade yielded highest at the EL harvest period and was significantly different in comparison to the EE, LE, and LL by at least 21%. The Jumbo grade also yielded significantly higher at the EL harvest period in comparison to the EE and LE planting/harvest periods by at least 60%. LL yielded significantly lower in comparison to all other planting/harvest periods. The Total yield category for the EL and the LE harvest periods yielded significantly higher, with EL yielding best by at least 14%, in comparison to the LL and the EE planting/harvest periods. The Canner grade differed. The LL and the LE planting/harvest periods ranked highest and were significantly different from the EE which yielded significantly higher than the EL planting/harvest period.

**2011 Results.** U.S. No. 1 grade yielded significantly higher for the EL harvest period in comparison to all other planting/harvest periods (Fig. 2.2). The EE harvest period yielded significantly higher in comparison to the LE and the LL planting/harvest periods. The EL harvest period yielded highest for all other grades in comparison to other planting/harvest periods. The LL harvest period consistently yielded lowest and differed significantly in comparison to all other planting/harvest periods in the Canners and Jumbo grades. Unexpectedly, LE yielded superior to LL in all grades. The Canner grade was the only category to deviate from this trend in which LE yielded second highest and EE fell to third highest but, the two planting/harvest periods were not significantly different.

### 2.3.2 Variety

Roots were analyzed according to variety for yield by grade. The two varieties were Beauregard (Bx) and Evangeline (Ev). The data presented in Fig. 2.3 and Fig. 2.4 represent average yield for Beauregard and Evangeline varieties across all grade categories. The results were similar across all grades.

**2010 Results.** The Beauregard variety yielded higher than Evangeline in all grade categories (Fig. 2.3). Beauregard yielded significantly higher in the U.S. No. 1 grade (10%) as well as the total yield grade (8%) in comparison to Evangeline.

**2011 Results.** The Beauregard variety yielded higher than Evangeline in all grade categories excluding the Canner grade (Fig.2.4). Beauregard yielded significantly higher in the U.S. No. 1 (30%), Ones+Jumbo (27%), and Total yield grade (21%) categories in comparison to Evangeline.

### 2.3.3 Plant Spacing

Roots were analyzed according to plant spacing for yield by grade. The two plant spacings were at 12 inches and 16 inches. The data presented in Fig. 2.5 and Fig. 2.6 represent average yield for the 12 inch and the 16 inch spacing across all grade categories.

**2010 Results.** The 12 inch spacing yielded significantly higher in the Canner grade (10%) category in comparison to the 16 inch spacing (Fig. 2.5). No other significant differences were detected.

**2011 Results.** The 12 inch spacing yielded higher in the Jumbo, Canner, and Total yield grade categories and significantly higher in comparison to the 16 inch spacing in the Canner grade (16%) category (Fig. 2.6). No other significant differences were detected.

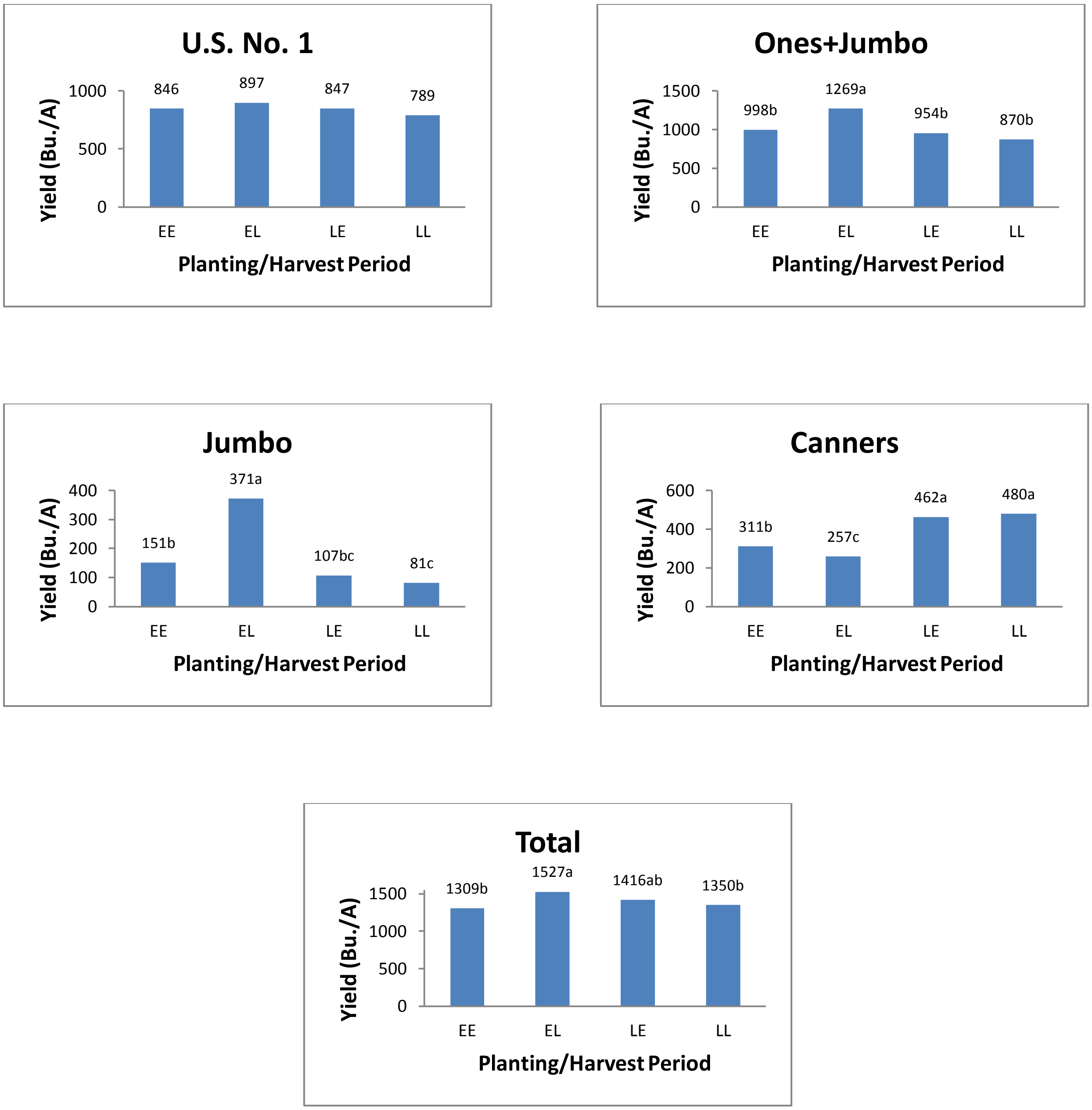


Figure 2.1. 2010 yields of both Evangeline and Beauregard varieties combined and shown by planting/harvest date combinations as EE (early planting - June 1/early harvest - October 8), EL (early planting - June 1/ late harvest - October 22), LE (late planting - June 30/early harvest - November 5), and LL (late planting - June 30/late harvest - November 19) for U.S. No. 1 (2 to 3.5 inches in diameter and 3 to 9 inches long and are straight, uniform roots, free of blemishes), Canner (1 to inches in diameter and 2 to 7 inches long), Jumbo (larger than U.S. #1 in diameter, length, or both and without objectionable defects), Ones+Jumbo (combination of U.S. No. 1 and Jumbo) and Total Yield (combination U.S. No. 1, Canner, and Jumbo) in 50 lb. bushels per acre. 1 metric ton = 44 bushels. Different letter designations between columns for a given size category represent significant differences at P=0.05.

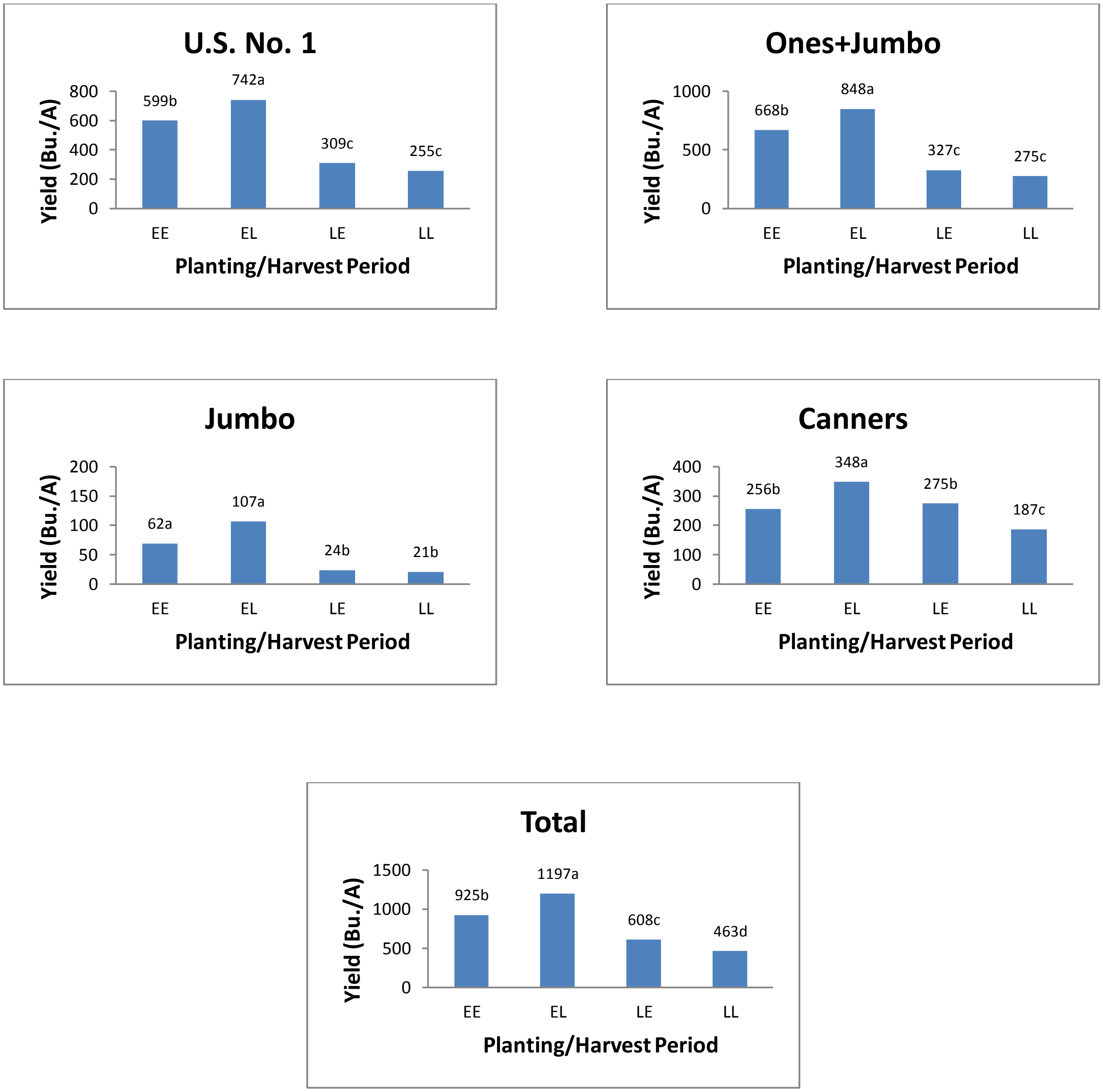


Figure 2.2. 2011 yields of both Evangeline and Beauregard varieties combined and shown by planting/harvest date combinations as EE (early planting - June 7/early harvest - October 11), EL (early planting - June 7/ late harvest - October 25), LE (late planting - July 8/early harvest - November 8), and LL (late planting - July 8/late harvest - November 22) for U.S. No. 1 (2 to 3.5 inches in diameter and 3 to 9 inches long and are straight, uniform roots, free of blemishes), Canner (1 to inches in diameter and 2 to 7 inches long), Jumbo (larger than U.S. #1 in diameter, length, or both and without objectionable defects), Ones+Jumbo (combination of U.S. No. 1 and Jumbo) and Total Yield (combination U.S. No. 1, Canner. and Jumbo) in 50 lb. bushels per acre. 1 metric ton = 44 bushels. Different letter designations between columns for a given size category represent significant differences at P=0.05.

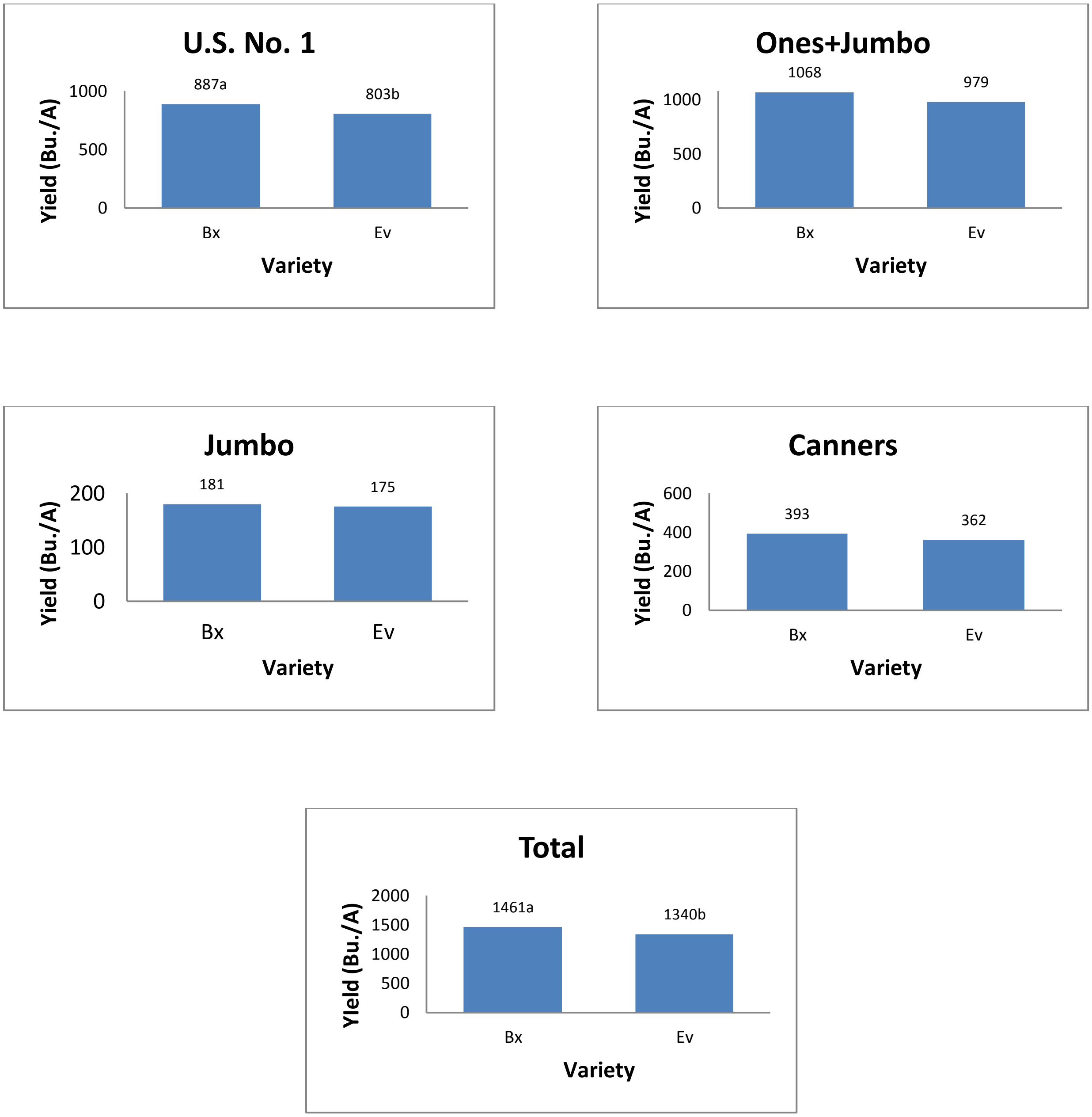


Figure 2.3. 2010 yields by variety for Beauregard (Bx) and Evangeline (Ev) varieties for U.S. No. 1 (2 to 3.5 inches in diameter and 3 to 9 inches long and are straight, uniform roots, free of blemishes), Canner (1 to inches in diameter and 2 to 7 inches long), Jumbo (larger than U.S. #1 in diameter, length, or both and without objectionable defects), Ones+Jumbo (combination of U.S. No. 1 and Jumbo) and Total Yield (combination U.S. No. 1, Canner. and Jumbo) in 50 lb. bushels per acre. 1 metric ton = 44 bushels. Different letter designations between columns for a given size category represent significant differences at P=0.05.

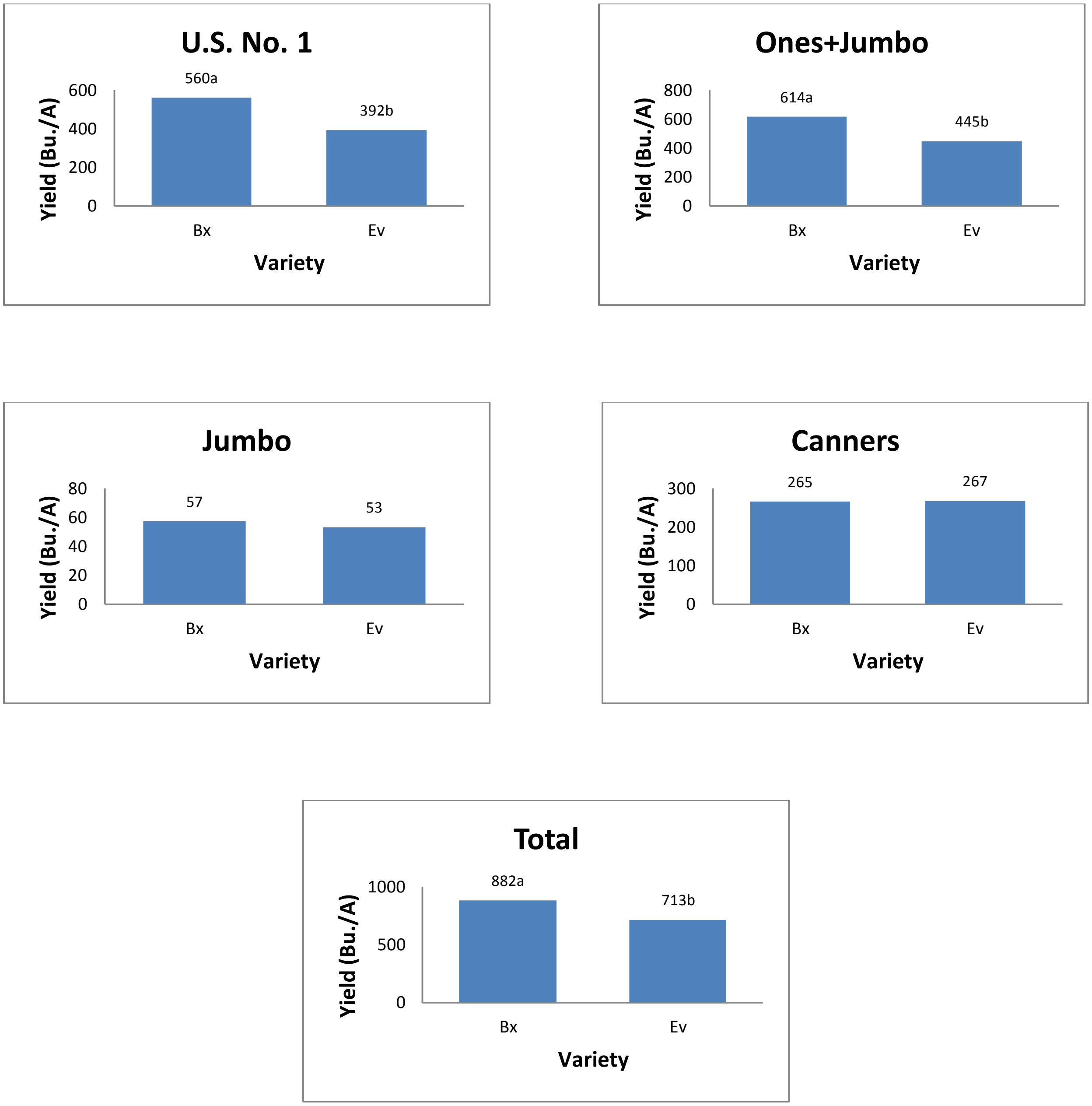


Figure 2.4. 2011 yields by variety for Beauregard (Bx) and Evangeline (Ev) varieties for U.S. No. 1 (2 to 3.5 inches in diameter and 3 to 9 inches long and are straight, uniform roots, free of blemishes), Canner (1 to inches in diameter and 2 to 7 inches long), Jumbo (larger than U.S. #1 in diameter, length, or both and without objectionable defects), Ones+Jumbo (combination of U.S. No. 1 and Jumbo) and Total Yield (combination U.S. No. 1, Canner. and Jumbo) in 50 lb. bushels per acre. 1 metric ton = 44 bushels. Different letter designations between columns for a given size category represent significant differences at P=0.05.

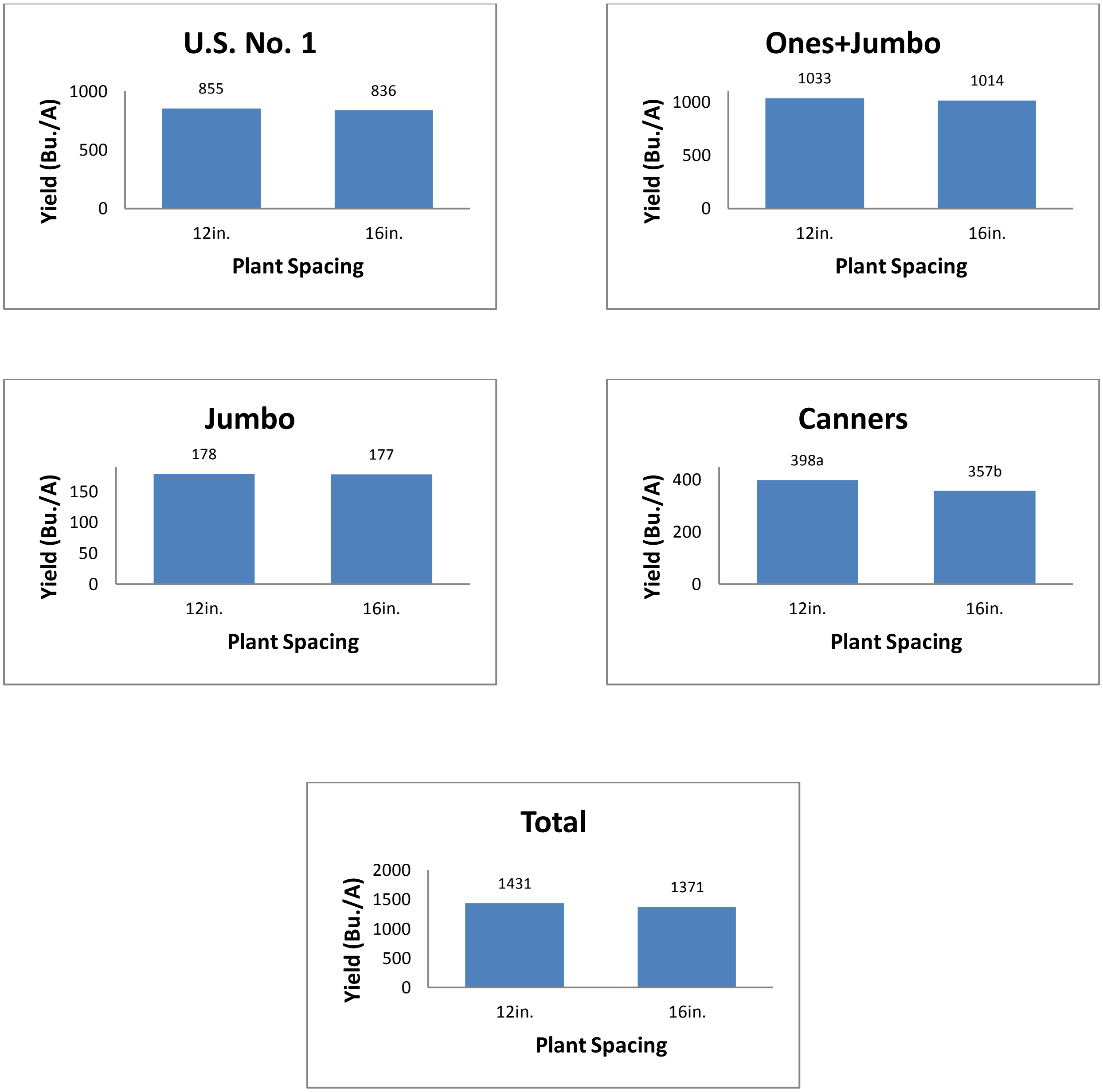


Figure 2.5. 2010 yields for Beauregard and Evangeline varieties combined and shown by plant spacing with the two spacings as 12 inches (12 in.) and 16 inches (16in.) for U.S. No. 1 (2 to 3.5 inches in diameter and 3 to 9 inches long and are straight, uniform roots, free of blemishes), Canner (1 to inches in diameter and 2 to 7 inches long), Jumbo (larger than U.S. #1 in diameter, length, or both and without objectionable defects), Ones+Jumbo (combination of U.S. No. 1 and Jumbo) and Total Yield (combination U.S. No. 1, Canner. and Jumbo) in 50 lb. bushels per acre. 1 metric ton = 44 bushels. Different letter designations between columns for a given size category represent significant differences at P=0.05.

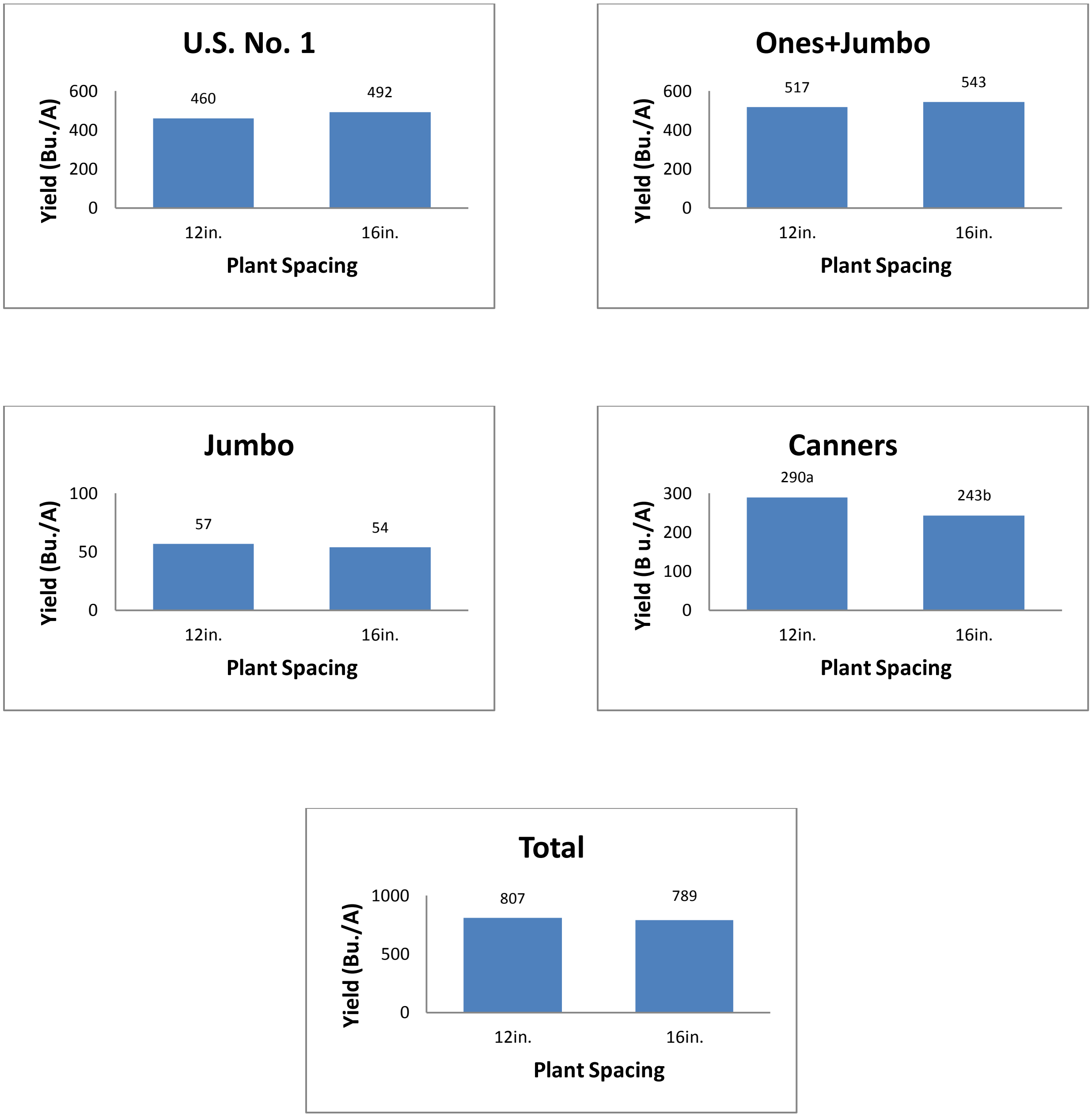


Figure 2.6. 2011 yields for Beauregard and Evangeline varieties combined and shown by plant spacing with the two spacings as 12 inches (12 in.) and 16 inches (16in.) for U.S. No. 1 (2 to 3.5 inches in diameter and 3 to 9 inches long and are straight, uniform roots, free of blemishes), Canner (1 to inches in diameter and 2 to 7 inches long), Jumbo (larger than U.S. #1 in diameter, length, or both and without objectionable defects), Ones+Jumbo (combination of U.S. No. 1 and Jumbo) and Total Yield (combination U.S. No. 1, Canner. and Jumbo) in 50 lb. bushels per acre. 1 metric ton = 44 bushels. Different letter designations between columns for a given size category represent significant differences at P=0.05.

### 2.3.4 Row Width

Roots were analyzed according to row width for yield by grade. The two row widths were 38 inches and 42 inches. Nominal differences were observed for the various grade categories across both years.

**2010 Results.** The 42 inch width yielded significantly higher in the Canner (27%) and Total yield grade (11%) categories in comparison to the 38 inch width (Fig. 2.7). All other categories were not significantly different.

**2011Results.** There were no significant differences detected between row widths across all grade categories (Fig. 2.8).

## 2.4 Discussion

**Harvest Date.** In most all grade categories, across both years, the early planting/late harvest combination was regarded as the best combination. In Louisiana, It is very important to get transplants planted as early as possible. Normally anything planted after July 1does not perform as well as those planted before this date (A. Villordon, 2012 Personal Communication). The delayed harvest was expected to achieve a higher tonnage and more Jumbo roots due to the fact that sweetpotato is indeterminate (Loebenstein and Thottappilly, 2009) so as long as there is no killing frost, the roots will continue growth. The early planting/late harvest combination ranked higher than any other planting/harvest combination in almost every instance. These results reinforce the importance of getting plants out as early as possible but, not until soil temperature is above 65°F (18°C) (A. Villordon, 2012 Personal Communication).

The increased tonnage and larger roots produced by using the harvest combination of early planting/late harvest could increase incomes significantly for the processing market. An example from the ones/jumbo category in each year can be used to explain this advantage. In

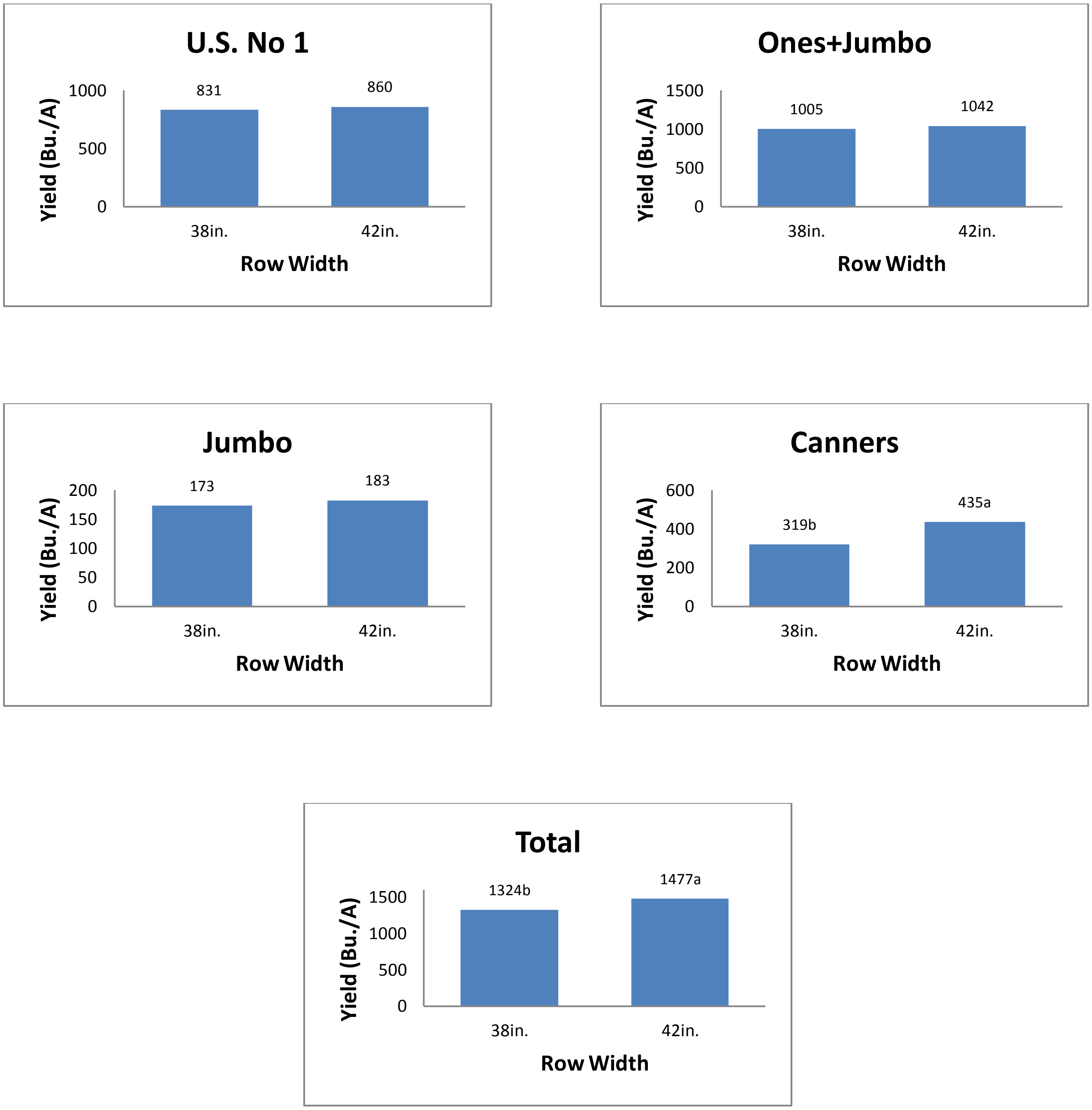


Figure 2.7. 2010 yields yields for Beauregard and Evangeline varieties combined and shown by row widths with the two widths as 38 inches (38in.) and 42 inches (42in.) for U.S. No. 1 (2 to 3.5 inches in diameter and 3 to 9 inches long and are straight, uniform roots, free of blemishes), Canner (1 to inches in diameter and 2 to 7 inches long), Jumbo (larger than U.S. #1 in diameter, length, or both and without objectionable defects), Ones+Jumbo (combination of U.S. No. 1 and Jumbo) and Total Yield (combination U.S. No. 1, Canner. and Jumbo) in 50 lb. bushels per acre. 1 metric ton = 44 bushels. Different letter designations between columns for a given size category represent significant differences at P=0.05.

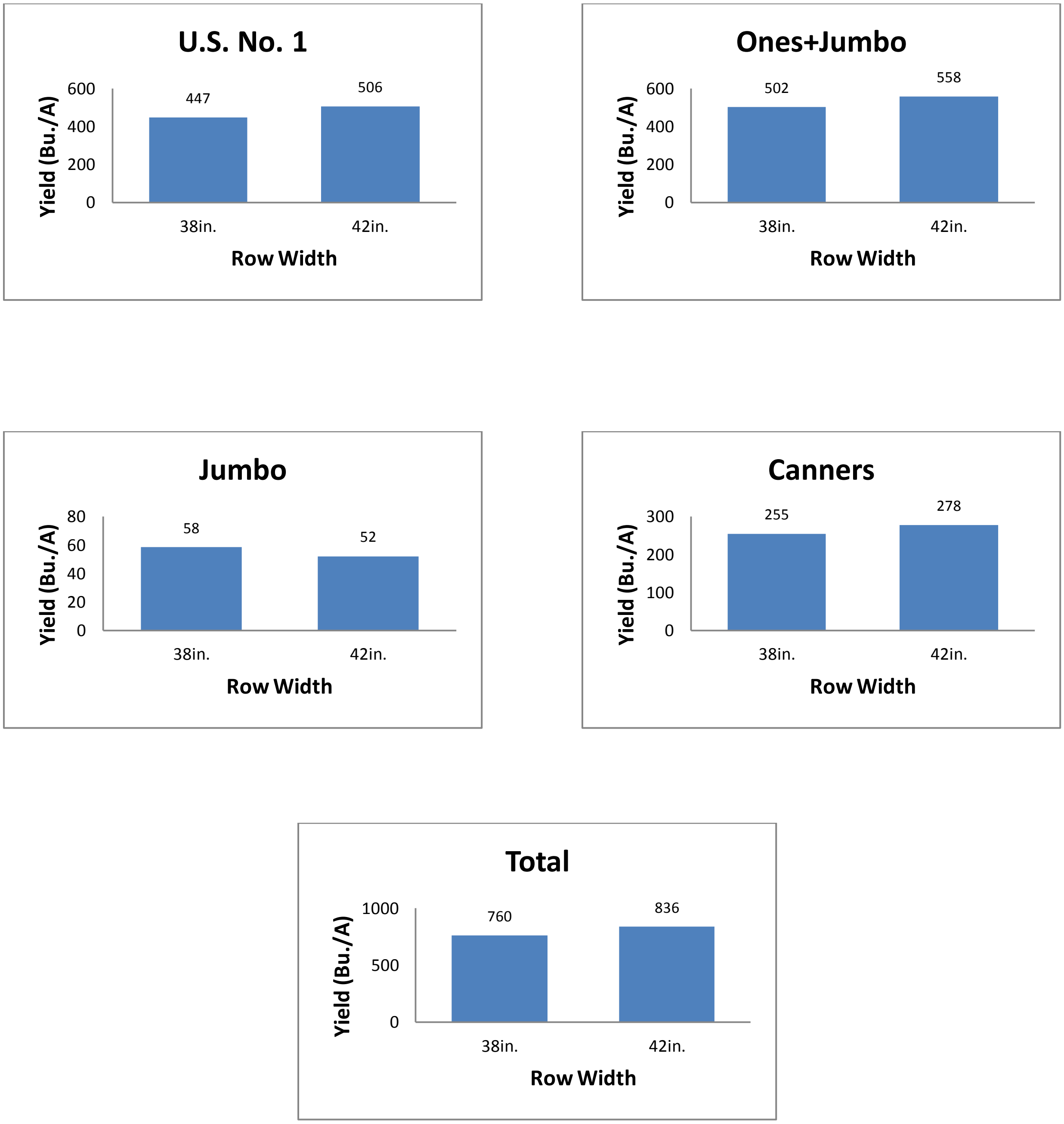


Figure 2.8. 2011 yields yields for Beauregard and Evangeline varieties combined and shown by row widths with the two widths as 38 inches (38in.) and 42 inches (42in.) for U.S. No. 1 (2 to 3.5 inches in diameter and 3 to 9 inches long and are straight, uniform roots, free of blemishes), Canner (1 to inches in diameter and 2 to 7 inches long), Jumbo (larger than U.S. #1 in diameter, length, or both and without objectionable defects), Ones+Jumbo (combination of U.S. No. 1 and Jumbo) and Total Yield (combination U.S. No. 1, Canner. and Jumbo) in 50 lb. bushels per acre. 1 metric ton = 44 bushels. Different letter designations between columns for a given size category represent significant differences at P=0.05.

2010 the early planting/late harvest combination yielded 33% higher than the late planting/ early harvest combination. In 2011 the early planting/late harvest combination yielded 68% higher than the late planting/late harvest combination. The early planting/late harvest combination yielded at least 22% higher than the next highest combination which, in both years, was the early planting/early harvest combination. The increased income realized by the use of this combination could be substantial. Table 2.1 (T. Smith, 2011 Personal Communication) shows that this increase in yield could be the difference in breaking even or losing money. The increase between 400 and 600 bushels per acre shown in Table 2.1 is slightly higher than the 22% increase in yield with a change of the planting/harvest combination. Table 2.2 shows revenue estimates for marketable roots (Ones+Jumbo) using the data presented at a price of $0.15 per pound, the average price paid for processing roots (T. Smith, 2011 Personal Communication).

Table 2.1. Revenue estimates for sweetpotato as a function of price and yield.

| **Input cost ($/acre)** | **Yield (bu/acre, lb/acre)** | **Price ($/lb)** | **Total revenue ($/acre)** | **Producer profit margin ($/acre)** |
|---|---|---|---|---|
| 3,000 | 400/20,000 | 0.10 | 2,000 | - 1,100 |
| 3,000 | 400/20,000 | 0.15 | 3,000 | Break even |
| 3,000 | 400/20,000 | 0.20 | 4,000 | 1,000 |
| 3,000 | 600/30,000 | 0.10 | 3,000 | Break even |
| 3,000 | 600/30,000 | 0.15 | 4,500 | 1,500 |
| 3,000 | 600/30,000 | 0.20 | 6,000 | 3,000 |

Table provided by T. Smith, 2011.

Table 2.2. Profits realized after input costs ($3000/acre) at $0.15 per pound price of roots harvested at various planting/harvest combinations.

| | **Early Planting/Early Harvest ($/acre)** | **Early Planting/Late Harvest ($/acre)** | **Late Planting/Early Harvest ($/acre)** | **Late Planting/Late Harvest ($/acre)** |
|---|---|---|---|---|
| 2010 | 4485 | 6517 | 4155 | 3525 |
| 2011 | 2010 | 3360 | -548 | -938 |

The present research demonstrated no loss in U.S. No. 1 yield when allowing for the roots to stay in the ground for a longer period of time. The Canners became U.S. No. 1 and the U.S. No. 1 became Jumbos. All grades followed this same basic trend excluding the canner grade in 2010. The U.S No. 1 yield increased 6% in 2010 and 20% in 2011 in 2 weeks after the first harvest. Jumbo yield increased 60% in 2010 and 40% in 2011. This higher Jumbo yield is especially valuable for the processing sector.

**Variety.** The Beauregard variety was significantly higher than the Evangeline variety in the U.S. No. 1 and the total category in both years. It was significantly higher in Ones+Jumbo category in 2011. Results countered expectations. Beauregard has been known to produce high tonnage but the quality is usually compromised. It is known to have longer more crooked roots than that of Evangeline. Yields were thought to be similar between these varieties. The quality of Beauregard in 2010 represented a U.S. No. 1 packout rate of 60%. Though Beauregard produced more overall, Evangeline was able to able to achieve this 60% packout rate. In 2011 Evangeline was still able to achieve a 55% U.S. No. 1 packout rate where Beauregard achieved 63%. In 2011 the weather may have been to blame for the poor performance in comparison to 2010 for both varieties.

**Plant Spacing.** Results showed no difference between use of either 12 or 16 inch plant spacings. There were only significant differences in the Canner category, which is the more inconsequential of all grades, in both years. All other categories in both years showed no significant differences due to plant spacing. In 2010, the 12 inch spacing differed little from the 16 inch spacing in the total yield category. Similarly in 2011, the 12 inch spacing differed little from the 16 inch spacing in the total yield category. The 16 inch spacing would still be the more advantageous of the spacings to use because of the decreased amount of plants needed per acre. Using a16 inch spacing on a 42 inch row width as opposed to a 12 inch plant spacing would save over 3,000 plants per acre. The wider spacing with less plants would more than pay for the minimal yield differences. Plant stock currently costs $20-25 per 1,000 plants for most common varieties, The savings also extend to the transplanting operation, given a lower planting density.

**Row Width.** There were few differences between a 38 inch and a 42 inch row width. The only significant difference shown in either year was in 2010 in the canner and total yield categories; the 42 inch spacing was significantly higher than the 38 inch spacing. The canner grade category is not considered a reliable tool in estimating the success of a crop. In 2010 the 42 inch width showed 26% higher canner yield than the 38 inch width. This large yield increase directly affected the total yield category causing a significant difference to be achieved in that category as well. There were no other significant differences in any other category across both years. The 42 inch spacing would be recommended in this case due to the decrease in the number of plants needed per acre. There could be instances where there is no other choice but to use the 38 inch spacing where the 42 inch spacing might not be applicable to other crops grown. The wider row width may have value in non-irrigated acreage, if water is scarce.

**2.5 Conclusions**

Results clearly indicate an early planting/late harvest date combination results in increased tonnage while maintaining the valuable Ones+Jumbo size roots. This is particularly valuable for a fresh market grower who wants to service both the fresh market and processing sector. Though the Beauregard variety performed better, the Evangeline could be used interchangeably. Leaving a crop to size longer does not negatively impact U.S. No. 1 productivity but, does extend the time the crop is susceptible to flooding and frost damage. Altering plant spacing and row width does not demonstrate any performance advantage and these practices are at the discretion of the grower. Future research should examine an even wider plant spacing to see if possibly an 18 inch or 24 inch spacing could achieve a higher percentage of

Jumbo roots. This would be more useful for growers who service the processing sector exclusively. Newer, high yielding varieties like L07-146 may not behave similarly and need to be tested.

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# CHAPTER 3: FIELD CURING AND SUGAR ANALYSIS

## 3.1 Introduction

With the advent of a bulk harvesting system in the sweetpotato industry, growers are in need of any cost cutting procedures to offset the price of expensive new harvest equipment required in this system. A major expense incurred by growers is the cost of curing. Curing is used to achieve many physiological changes that must occur in the roots, including an increase in sugar and the healing of wounds incurred before storage, to optimize storage life and resistance to weight loss. Roots stored at proper temperatures can be stored for up to a year. Proper curing is the way to achieve such long storage periods (Picha, 1987).

The need for curing rooms and the heating costs involved could be avoided if the curing process could begin in the field before harvest but after de-vining. The onset of curing could help the grower reduce skinning damage (LaBonte and Wright, 1993) and also achieve a higher sugar content that results in a better tasting product to the customer. This “field curing” could allow the grower to carry his product straight to the processing plant without the storage costs incurred while curing or the roots could go straight to bulk piling without an intermediate curing step.

The possibility of this “field curing” could potentially save the grower some storage and handling costs in the short run but, the roots produced later in the year would more than likely have to go into routine curing. The reason for this assumption is that the temperature in the field would simply not be high enough to induce this possible curing late in the harvest season. It seems unlikely that late season field curing will mimic traditional curing with the intended effect of increasing sugar content. No previous research has been reported on this subject so we are interested to test this hypothesis.

It is recommended that roots should be cured at 85-90°F with a relative humidity of 90-95% for 4 to 10 days. This curing not only helps the visual appeal of the root and heals wounds but, it also plays a vital role in increasing the sugar content and, in turn, the taste of the sweetpotato. Sucrose is the most important of the sugars in sweetpotato because it is what gives the sweetpotato the sweet taste that shoppers desire (LaBonte *et al.*, 2000). Sweetpotatoes are shown to have a sharp increase in sucrose and total sugar content immediately after the curing process is complete. Fructose and glucose remain constant and maltose is not present in the raw product. Sucrose content has been shown to increase from 6 to 10 grams per 100 grams of total root dry weight after 10 days in a curing environment. Further increases are achieved after 46 weeks in storage at 15.6°C and 90-95 % relative humidity (Picha, 1987). The present study examines the effects of field curing on sugar content in sweetpotato storage roots.

**3.2 Materials and Methods**

The foundation seed plots at The Sweet Potato Research Station in Chase, Louisiana were used to evaluate physiological changes in storage roots. Both Evangeline and Beauregard varieties were used. The experiments took place in the fall of 2010 and 2011. Random plots marked off in 4-row blocks. A section of the plots were de-vined each day for five consecutive days with day 0 being harvested and devined the same day, day 1 being harvested 1 day after devining, day 2 being harvested 2 days after devining, day 3 being harvested 3 days after devining, and day 4 being harvested 4 days after devining. There was an early (~September 1) and a late harvest (~November 1). Air and soil temperature data was taken from weather station archives from Chase, Louisiana for 2010 (Tables 3.1 and 3.2) and 2011 (Tables 3.3 and 3.4). In addition, soil surface temperatures on bare ground and soil temperatures under the leaf canopy of the plot were taken in 2011 (Tables 3.5 and 3.6).

The soil type was a Gilbert silt loam and 4-11-11 fertilizer was applied at a rate of 1000 pounds (454.5 kg) per acre. The plot was irrigated just after planting and subsequently at 25-50% field capacity throughout the growing season. Typical cultural practices were followed throughout the year as recommended by the Southeastern U.S. Vegetable Crop Handbook (Kemble *et al*., 2012).

Storage root tissue was evaluated for sugar content using high performance liquid chromatography (HPLC). In brief, 10 gram root samples were ground and boiled in ethanol, and brought to volume. Filtered samples are then injected into an HPLC for sugar determination (LaBonte *et al.*, 2000). This sugar analysis was performed on both the raw sweetpotato root and the cooked, French fry product. The roots were cut into fries and then a raw sample taken for sugar determination. There were three replications of each treatment. A second batch of raw fries is processed as fries using standard industry recommendations. Fry strips are immersed in hot water for two minutes then immediately submerged in a hot water bath treated with 7.5% sodium acid pyrophosphate for 30 seconds. These fries are then weighed and placed in a dryer to remove 10% of the weight. They are then fried in oil for 45 seconds at 190°C. These fries are then frozen. The frozen product is then fried at 190°C for one minute and fifteen seconds. Sugars in the fried product are then processed as before for determination of sugars to assess changes in sugar (Walter Jr. and Hoover, 1986).

**3.3 Results**

Data documenting the sugar contents of raw and French fry samples of Beauregard and Evangeline sweetpotato varieties was analyzed using PROC GLM at the P=0.05 significance level using Duncan’s multiple range test (9.3, SAS Institute Inc, Cary, N.C.). Sucrose, fructose, glucose, and maltose contents as well as total sugar contents were determined for each sample. Each variety/harvest combination was analyzed separately for raw and fried product.

### 3.3.1 Temperature Data

Data was collected for the daily minimum and maximum air temperatures as well as the soil temperatures in 2010 (Tables 3.1 and 3.2). The daily minimum and maximum air temperatures were determined and plot soil temperatures were taken under the leaf canopy and on bare plot ground at a 15.25cm depth in 2011(Tables 3.3, 3.4, 3.5, and 3.6). In 2010 maximum temperatures from the early harvest (soil ~32°C, air ~35°C) were ~10 degrees higher in comparison to the temperatures from the late harvest (soil ~21°C, air ~24°C). Most minimum air temperatures from the early harvest were similar to that of the late harvest. Two of the days (20 degrees higher at night) were extreme for the early harvest (~24°C) while the other three days were only 1 to 3 degrees higher for the early harvest (16-18°C) in comparison to the late harvest (13-16°C). Maximum and minimum soil temperatures were 10 to 12 degrees higher for the early harvest (min ~27°C, max ~32°C) in comparison to the late harvest (min ~16°C, max~21°C). In 2011 most maximum temperatures from the early harvest (soil ~27°C, air ~32°C) were 8 to 10 degrees higher in comparison to the temperatures for the late harvest (soil ~18°C, air ~24°C). Most minimum temperatures for the early harvest (soil ~24°C air ~18°C) were higher in comparison to the late harvest (soil ~16°C, air 10°C). Data was collected at the plot site in 2011. Maximum temperatures on bare ground (~27°C) were 1 to 3 degrees higher in comparison to the temperatures under the canopy (~24°C). Minimum temperatures on bare ground were 1 to 4 degrees higher in comparison to the temperatures under the canopy for the early harvest. Maximum temperatures on bare ground (~18°C) were less than 2 degrees higher in comparison to the temperatures under the canopy (~18°C) for the late harvest. Minimum temperatures on bare ground (~13°C) were 1 to 3 degrees higher in comparison to the temperatures under the canopy (~10°C) for the late harvest. Maximum temperatures on bare ground were 5 to 10 degrees higher for the early harvest (~27°C) in comparison to the late harvest (~18°C).

Maximum temperatures under the canopy were 3 to 7 degrees higher for the early harvest (~24°C) in comparison to the late harvest (~18°C). Minimum temperatures on bare ground were 8 to 10 degrees higher for the early harvest (~24°C) in comparison to the late harvest (~13°C). Minimum temperatures under the canopy were 5 to 10 degrees higher for the early harvest (~21°C) in comparison to the late harvest (~10°C). Minimum and maximum soil temperatures taken from weather station archives were very similar to the plot data taken in 2011 in both the early harvest and late harvest. The temperatures from the weather station archives were within 3 degrees being higher or lower in comparison to the plot data.

Table 3.1. Weather station data (Chase, LA) for minimum and maximum air and soil temperatures for the early season harvest of roots for sugar analysis in 2010. Temperatures were taken at depths of 0, 5, 10, and 25cm and are represented in degrees Celsius.

| Date | Minimum Air Temperature | Maximum Air Temperature | Minimum Soil Temperature | Maximum Soil Temperature |
|---|---|---|---|---|
| 9/11/2010 | 23.3 | 36.7 | 26.6 | 32.2 |
| 9/12/2010 | 24.4 | 34.4 | 27.3 | 32.2 |
| 9/13/2010 | 18.4 | 34.4 | 25 | 32.2 |
| 9/14/2010 | 15.6 | 35 | 23.3 | 30.6 |
| 9/15/2010 | 17.2 | 34.4 | 23.3 | 30.6 |

Table 3.2. Weather station (Chase, LA) data for minimum and maximum air and soil temperatures for the late season harvest of roots for sugar analysis in 2010. Temperatures were taken at depths of 0, 5, 10, and 25cm and represented in degrees Celsius.

| Date | Minimum Air Temperature | Maximum Air Temperature | Minimum Soil Temperature | Maximum Soil Temperature |
|---|---|---|---|---|
| 10/30/2010 | 3.4 | 26.1 | 12.8 | 22.2 |
| 10/31/2010 | 6.7 | 28.3 | 13.9 | 22.8 |
| 11/1/2010 | 16.1 | 23.8 | 18.4 | 22.2 |
| 11/2/2010 | 16.1 | 20 | 18.9 | 21.1 |
| 11/3/2010 | 14.4 | 18.4 | 17.8 | 19.5 |

Table 3.3. Weather station (Chase, LA) data for minimum and maximum air and soil temperatures for the early season harvest of roots for sugar analysis in 2011. Temperatures were taken at depths of 0, 5, 10, and 25cm and represented in degrees Celsius.

| Date | Minimum Air Temperature | Maximum Air Temperature | Minimum Soil Temperature | Maximum Soil Temperature |
|---|---|---|---|---|
| 9/17/2011 | 13.9 | 32.2 | 23.4 | 26.1 |
| 9/18/2011 | 21.6 | 31.1 | 25 | 26.1 |
| 9/19/2011 | 19.5 | 28.4 | 25 | 26.7 |
| 9/20/2011 | 18.4 | 31.1 | 24.5 | 27.3 |
| 9/21/2011 | 17.8 | 32.2 | 24.5 | 27.3 |

Table 3.4. Weather station (Chase, LA) data for minimum and maximum air and soil temperatures for the late season harvest of roots for sugar analysis in 2011. Temperatures were taken at depths of 0, 5, 10, and 25cm and are represented in degrees Celsius.

| Date | Minimum Air Temperature | Maximum Air Temperature | Minimum Soil Temperature | Maximum Soil Temperature |
|---|---|---|---|---|
| 11/4/2011 | 3.9 | 17.8 | 12.8 | 16.7 |
| 11/5/2011 | 3.4 | 22.2 | 13.3 | 16.7 |
| 11/6/2011 | 11.1 | 26.7 | 14.5 | 17.8 |
| 11/7/2011 | 11.7 | 27.8 | 16.1 | 19.5 |
| 11/8/2011 | 14.5 | 26.7 | 17.8 | 20 |

Table 3.5. Plot data for minimum and maximum soil temperatures on bare ground and under the leaf canopy for the early season harvest of roots for sugar analysis in 2011. Temperatures were taken at 15.25cm are represented in degrees Celsius.

| Date | Minimum Soil Temperature (Under Canopy) | Maximum Soil Temperature (Under Canopy) | Minimum Soil Temperature (Bare Ground) | Maximum Soil Temperature (Bare Ground) |
|---|---|---|---|---|
| 9/17/2011 | 17.6 | 24.2 | 21.5 | 27.8 |
| 9/18/2011 | 22.8 | 25.0 | 24.2 | 27.9 |
| 9/19/2011 | 23.1 | 24.7 | 24.3 | 26.8 |
| 9/20/2011 | 22.8 | 25.4 | 23.3 | 28.9 |
| 9/21/2011 | 22.5 | 24.1 | 23.5 | 26.1 |

Table 3.6. Plot data for minimum and maximum soil temperatures on bare ground and under the leaf canopy for the late season harvest of roots for sugar analysis in 2011. Temperatures were taken at 15.25cm and are represented in degrees Celsius.

| Date | Minimum Soil Temperature (Under Canopy) | Maximum Soil Temperature (Under Canopy) | Minimum Soil Temperature (Bare Ground) | Maximum Soil Temperature (Bare Ground) |
|---|---|---|---|---|
| 11/4/2011 | 7.2 | 17.1 | 10.5 | 15.8 |
| 11/5/2011 | 11.5 | 18.4 | 10.3 | 17.6 |
| 11/6/2011 | 14.2 | 20.2 | 13.3 | 20.4 |
| 11/7/2011 | 15.7 | 21.6 | 15.1 | 21.2 |
| 11/8/2011 | 17.6 | 21.1 | 17.1 | 21.3 |

### 3.3.2 Raw early harvested Beauregard

Raw samples of the Beauregard variety were analyzed for sugar content. In 2010 total sugar content and sucrose content were identical because no measurable amounts of fructose, glucose, or maltose were present. There was no measurable amount of maltose present in 2011. These results showed no significant trend in increased sugar content as the de-vining period was extended in comparison to the day 0 control.

**2010 Results.** There were no significant differences between days in any of the types of sugars that were present (Fig. 3.1).

**2011 Results.** There were no significant differences detected between days in any of the types of sugars that were present (Fig. 3.2).

**3.3.3 Raw early harvested Evangeline**

Raw samples of the Evangeline variety were analyzed for sugar content. In 2010 total sugar content and sucrose content were identical due to the fact that no measurable amounts of fructose, glucose, or maltose were present. There was no measurable amount of maltose present in 2011. These results showed no significant trend in increased sugar content as the de-vining period was extended in comparison to the day 0 control.

**2010 Results.** There were no significant differences detected between days in any of the types of sugars that were present (Fig. 3.3).

**2011 Results.** There were no significant differences detected between days in sucrose, fructose, and total sugar content (Fig. 3.4). Glucose contents for day 1 and day 3 were significantly higher in comparison to the glucose content of day 2. Day 0 and day 4 were not significantly different in comparison to any of the other days. No trend was apparent.

**3.3.4 Raw late harvested Beauregard**

Raw samples of the Beauregard variety were analyzed for sugar content. In 2010 no measurable amounts of glucose or maltose were present. There was no measurable amount of maltose present in 2011. These results showed no significant trends in increased sugar content as the de-vining period was extended in comparison to the day 0 control excluding sucrose in 2010; sucrose content rose significantly.

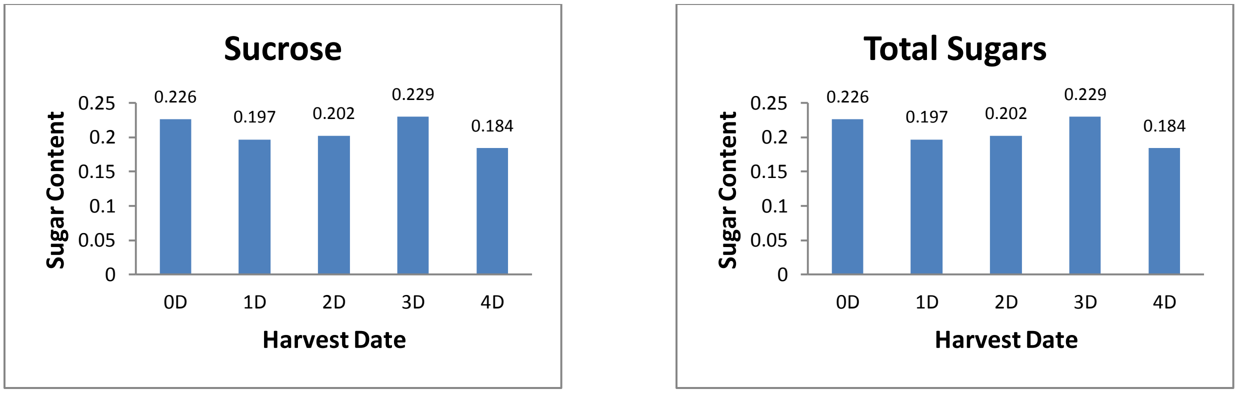



Figure 3.1. Sucrose and total sugar content of the raw early harvested Beauregard variety shown by 0 day (0D), 1 day (1D), 2 days (2D), 3 days (3D), and 4 days (4D) after de-vining before harvest for 2010. Different letter designations between columns on a given harvest day represent significant differences at P=0.05. Sugar contents are represented in milligrams per gram of fresh weight.

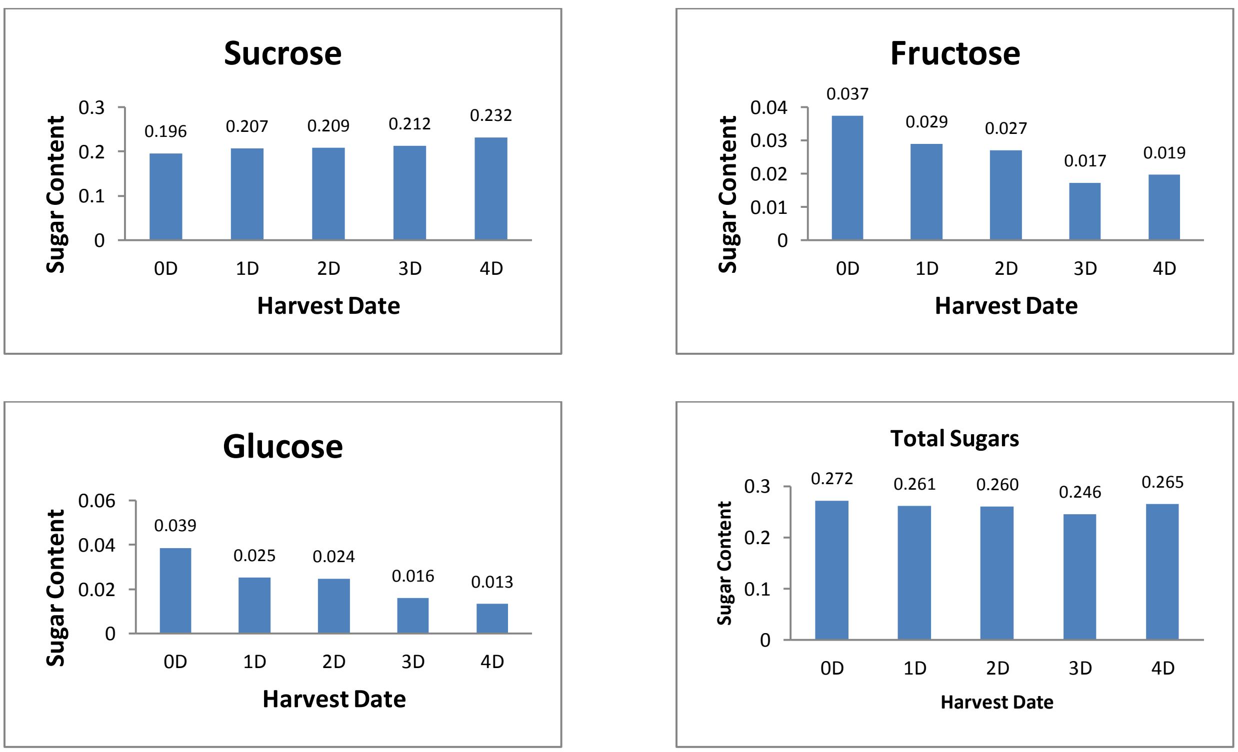



Figure 3.2. Sucrose, fructose, glucose, and total sugar content of the raw early harvested Beauregard variety shown by 0 day (0D), 1 day (1D), 2 days (2D), 3 days (3D), and 4 days (4D) after de-vining before harvest for 2011. Different letter designations between columns on a given harvest day represent significant differences at P=0.05. Sugar contents are represented in milligrams per gram of fresh weight.

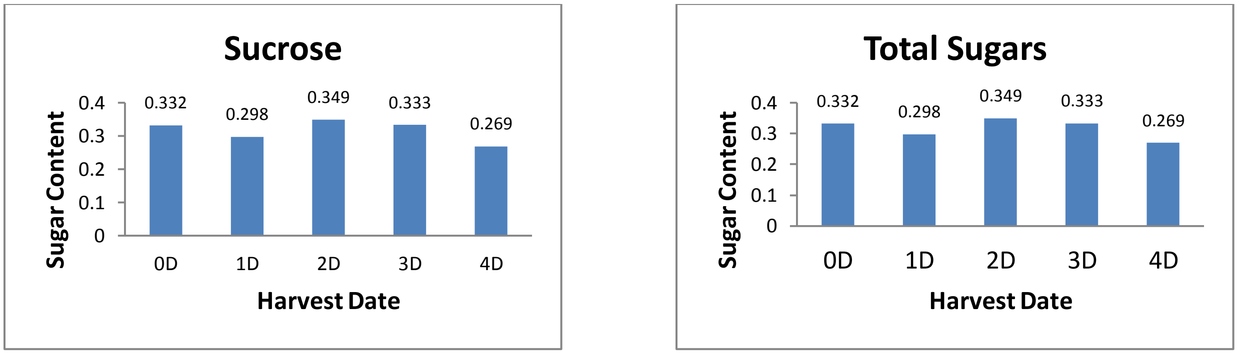



Figure 3.3. Sucrose and total sugar content of the raw early harvested Evangeline variety shown by 0 day (0D), 1 day (1D), 2 days (2D), 3 days (3D), and 4 days (4D) after de-vining before harvest for 2010. Different letter designations between columns on a given harvest day represent significant differences at P=0.05. Sugar contents are represented in milligrams per gram of fresh weight.

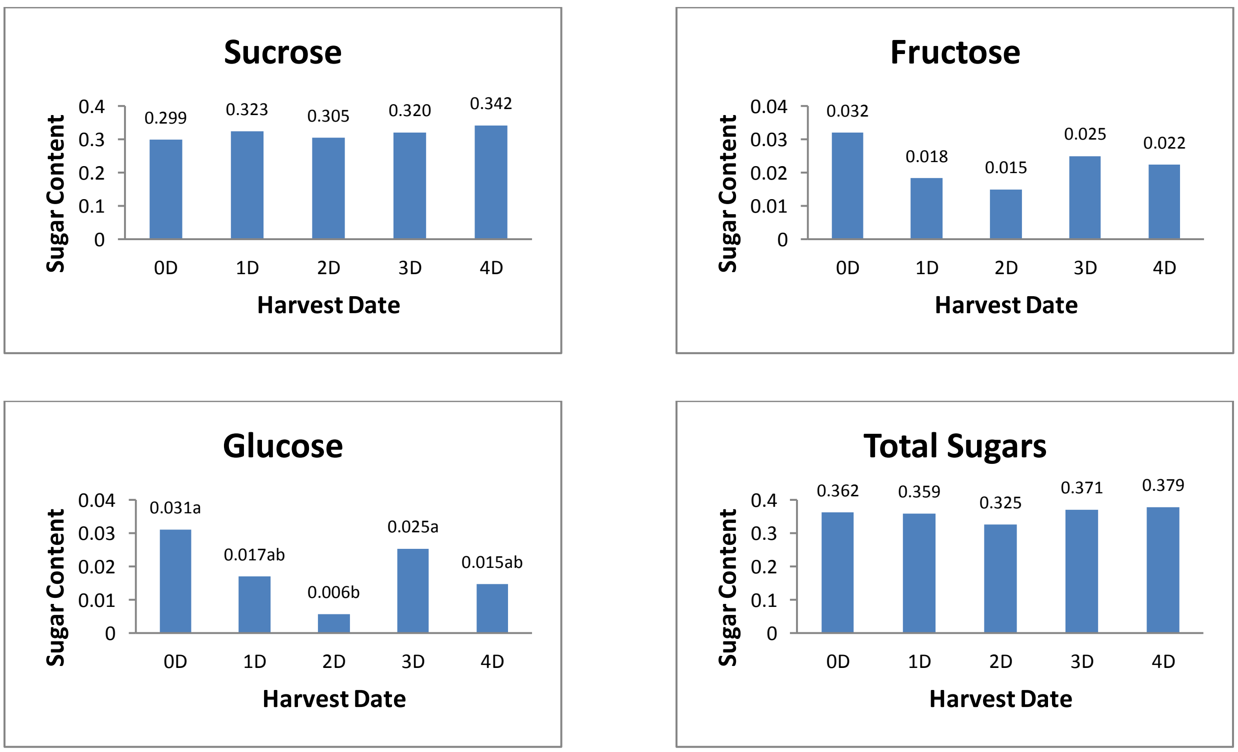



Figure 3.4. Sucrose, fructose, glucose, and total sugar content of the raw early harvested Evangeline variety shown by 0 day (0D), 1 day (1D), 2 days (2D), 3 days (3D), and 4 days (4D) after de-vining before harvest for 2011. Different letter designations between columns on a given harvest day represent significant differences at P=0.05. Sugar contents are represented in milligrams per gram of fresh weight.

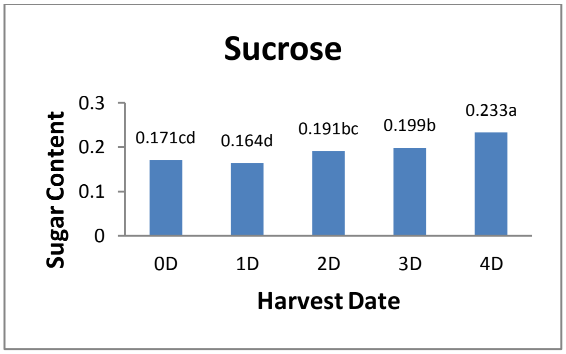
**2010 Results.** There were no significant differences between days in fructose content (Fig. 3.5). There was a linear decrease in sucrose content over the treatment period, i.e. as devining period decreased or was extended. The sugar content in day 4 was the highest ranking. There was little relative difference in rank between day 0 and 1. Significant differences were observed. The 4 day devining treatment was significantly higher in sucrose in comparison to the day 0, day 1, day 2 and day 3. Day 3 also differed in sucrose in comparison to day 0 and 1. Day 0 was not significantly different in comparison to day 2. Total sugar contents for day 4 were significantly higher in comparison to day 0 and day 1. There were no significant differences between day 3 in comparison to day 2 or day 0 and, there were no significant differences between day 0 in comparison to day 1.

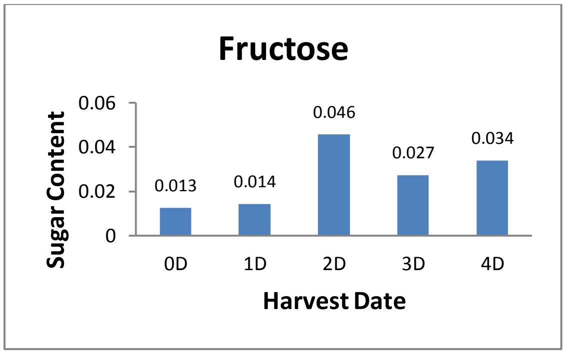
**2011 Results.** There were no significant differences between days in sucrose, glucose, or total sugar contents (Fig. 3.6). Fructose contents for day 0 and day 4 were significantly higher in comparison to day 1. Day 0 and day 4 were not significantly different in comparison to day 2 or day 3. There was no significant difference between day 1 in comparison to day 2 or day 3.

### 3.3.5 Raw late harvested Evangeline

Raw samples of the Evangeline variety were analyzed for sugar content. In 2010 total sugar content and sucrose content were identical due to the fact that no measurable amounts of fructose, glucose, or maltose were present. There was no measurable amount of maltose present in 2011. These results showed no significant trend in increased sugar content as the de-vining period was extended in comparison to the day 0 control excluding sucrose in 2010. The general trend in 2010 showed that as the de-vining period was extended, the sucrose content rose significantly.

**2010 Results.** Sucrose content for day 4 was significantly higher in comparison to day 1 and day 2. Day 0 and day 3 were not significantly different in comparison to all other days (Fig.



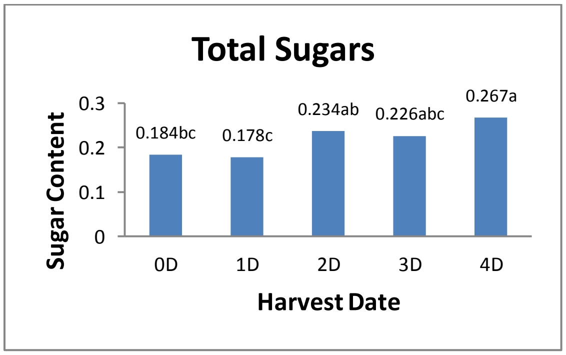




Figure 3.5. Sucrose, fructose, and total sugar content of the raw late harvested Beauregard variety shown by 0 day (0D), 1 day (1D), 2 days (2D), 3 days (3D), and 4 days (4D) after de-vining before harvest for 2010. Different letter designations between columns on a given harvest day represent significant differences at P=0.05. Sugar contents are represented in milligrams per gram of fresh weight.

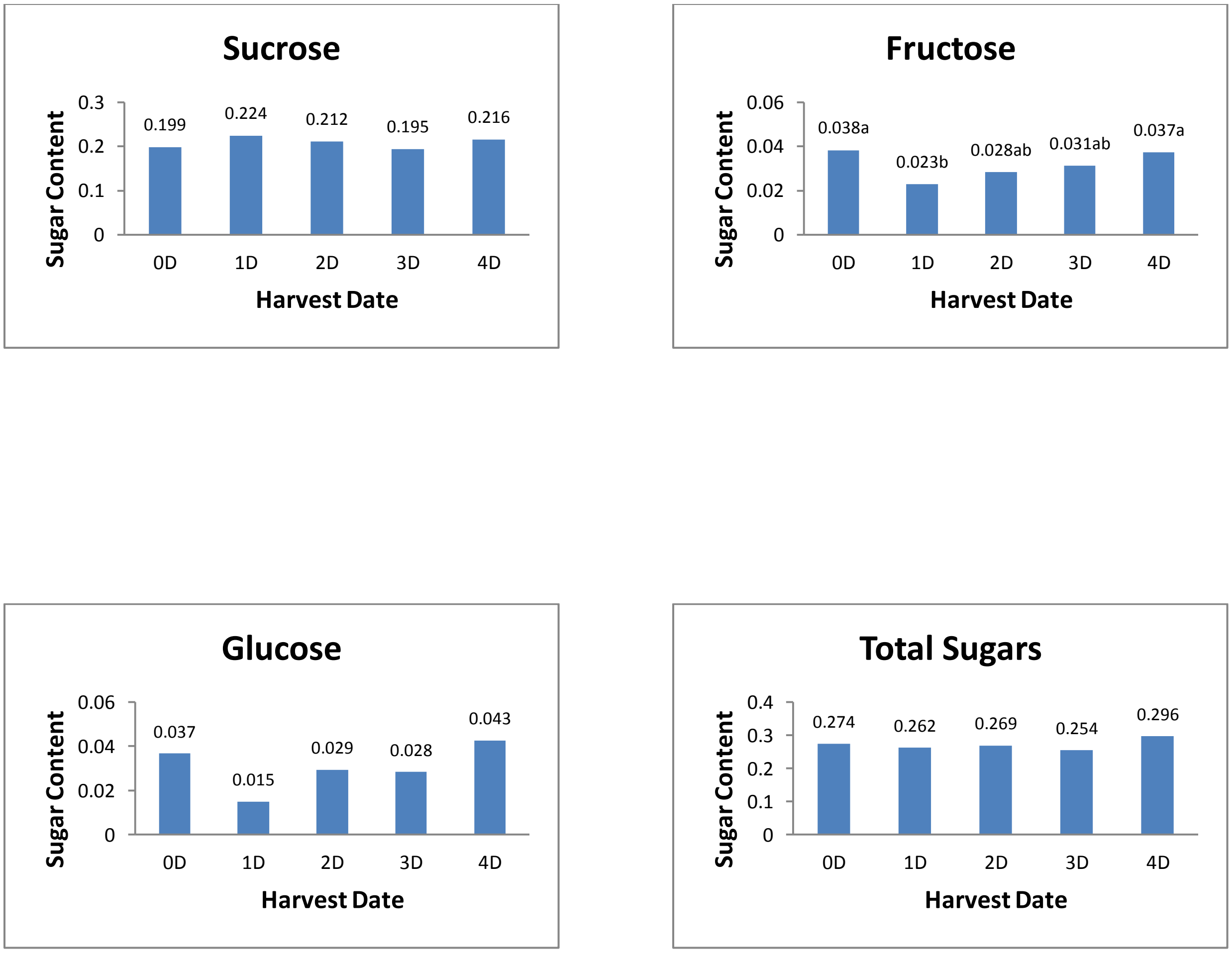



Figure 3.6. Sucrose, fructose, glucose, and total sugar content of the raw late harvested Beauregard variety shown by 0 day (0D), 1 day (1D), 2 days (2D), 3 days (3D), and 4 days (4D) after de-vining before harvest for 2011. Different letter designations between columns on a given harvest day represent significant differences at P=0.05. Sugar contents are represented in milligrams per gram of fresh weight.

3.7). Total sugar contents mirrored that of sucrose contents due to no other measurable sugars being present.

**2011 Results.** There were no significant differences between days in any of the types of sugars that were present (Fig. 3.8).

### 3.3.6 Fried early harvested Beauregard

Fried samples of the Beauregard variety were analyzed for sugar content. There were no measurable amounts of fructose or glucose in 2010. These results showed a general trend in all sugars, excluding sucrose, showed that as the de-vining period was extended, the sugar contents decreased.

**2010 Results.** There were no significant differences between days in any of the types of sugars that were present (Fig. 3.9).

**2011 Results.** There were no significant differences between days in sucrose, maltose, and total sugar contents (Fig. 3.10). Fructose content for day 0 was significantly higher in comparison to day 4. Day 1, day 2, and day 3 were not significantly different from any other days. Glucose content for day 0 was significantly higher in comparison to day 4. Day 1, day 2, and day 3 were not significantly different from any other days.

### 3.3.7 Fried early harvested Evangeline

Fried samples of the Evangeline variety were analyzed for sugar content. These results showed no significant trend in increased sugar content as the de-vining period was extended in comparison to the day 0 control.

**2010 Results.** There were no significant differences in sucrose content (Fig. 3.11). Maltose content for day 0 and day 2 were significantly higher in comparison to day 4. Day 1 and day 3 were not significantly different in comparison to all other days. Total sugar content for day 0, day 1, day 2, and day 3 were significantly higher in comparison to day 4.

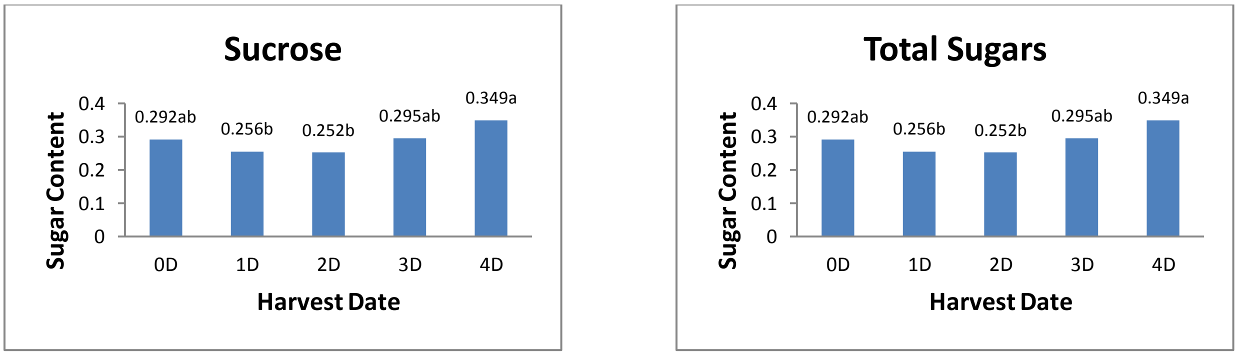



Figure 3.7. Sucrose and total sugar content of the raw late harvested Evangeline variety shown by 0 day (0D), 1 day (1D), 2 days (2D), 3 days (3D), and 4 days (4D) after de-vining before harvest for 2010. Different letter designations between columns on a given harvest day represent significant differences at P=0.05. Sugar contents are represented in milligrams per gram of fresh weight. .

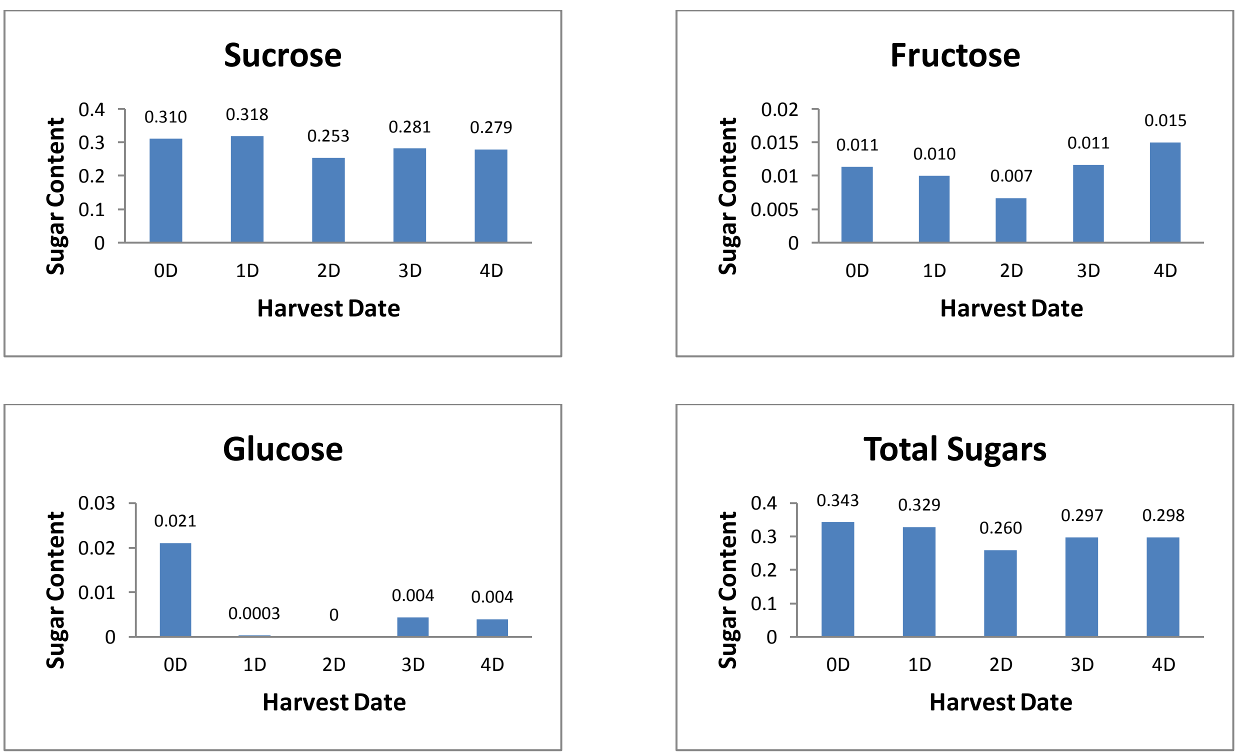
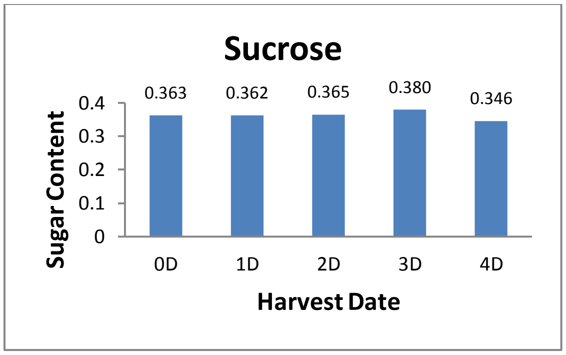
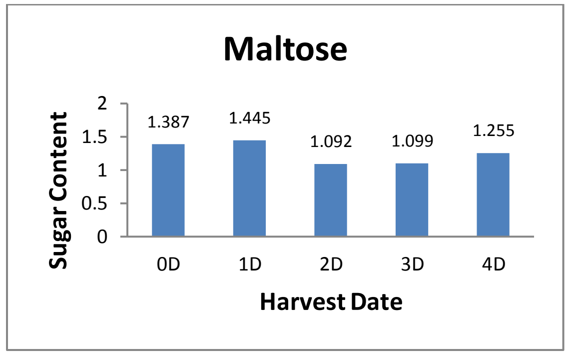



Figure 3.8. Sucrose and total sugar content of the raw late harvested Evangeline variety shown by 0 day (0D), 1 day (1D), 2 days (2D), 3 days (3D), and 4 days (4D) after de-vining before harvest for 2011. Different letter designations between columns on a given harvest day represent significant differences at P=0.05. Sugar contents are represented in milligrams per gram of fresh weight.



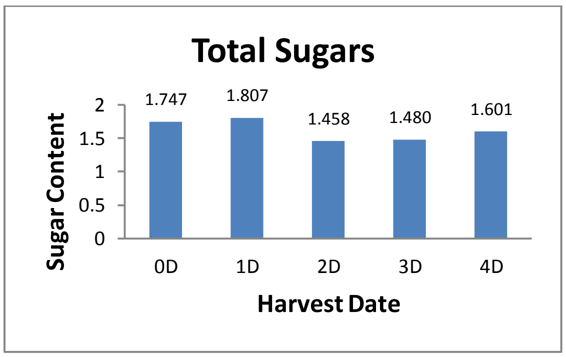




Figure 3.9. Sucrose, maltose, and total sugar content of the fried early harvested Beauregard variety shown by 0 day (0D), 1 day (1D), 2 days (2D), 3 days (3D), and 4 days (4D) after de-vining before harvest for 2010. Different letter designations between columns on a given harvest day represent significant differences at P=0.05. Sugar contents are represented in milligrams per gram of fresh weight.

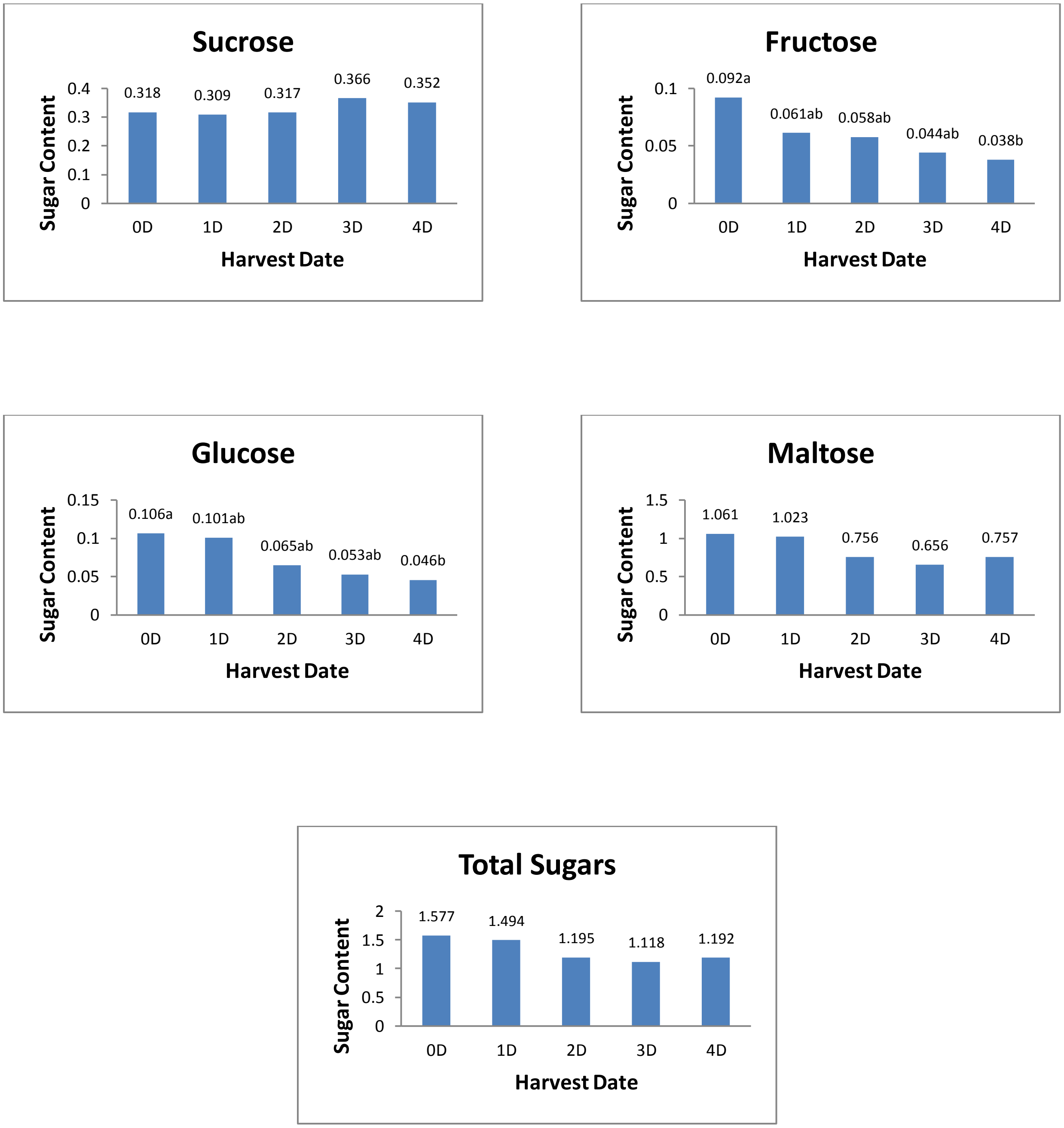



Figure 3.10. Sucrose, fructose, glucose, maltose, and total sugar content of the fried early harvested Beauregard variety shown by 0 day (0D), 1 day (1D), 2 days (2D), 3 days (3D), and 4 days (4D) after de-vining before harvest for 2011. Different letter designations between columns on a given harvest day represent significant differences at P=0.05. Sugar contents are represented in milligrams per gram of fresh weight.

**2011 Results.** There were no significant differences detected between days in any of the types of sugars (Fig 3.12).

### 3.3.8 Fried late harvested Beauregard

Fried samples of the Beauregard variety were analyzed for sugar content. There were measurable amounts of glucose only for day 2 and day 0. These results showed no significant trend in increased sugar content as the de-vining period was extended in comparison to the day 0 control.

**2010 Results.** There were no significant differences in sucrose, fructose, glucose, or total sugar content (Fig. 3.13). Maltose content for day 0, day 1, and day 4 was significantly higher in comparison to day 2 and day 3.

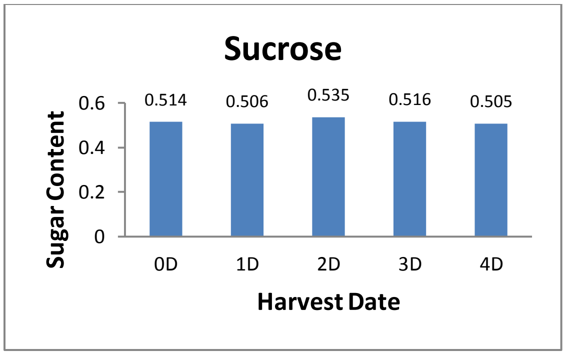
**2011 Results.** There were no significant differences in maltose or total sugar content (Fig.3.14). Sucrose content for day 1 was significantly higher in comparison to all other days. Day 4 was significantly higher in comparison to day 0, day 2, and day 3. Day 2 was significantly higher in comparison to day 2 and day 3. Fructose content for day 0 was significantly higher in comparison to day 1. Glucose content for day 0 was significantly higher in comparison to day 1 and day 3.

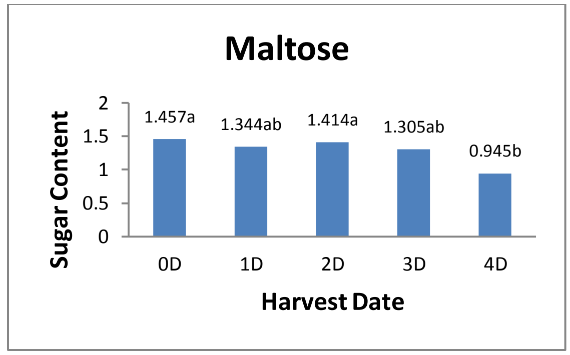
### 3.3.9 Fried late harvested Evangeline

Fried samples of the Evangeline variety were analyzed for sugar content. There were only measurable amounts of glucose at day 1. These results showed no significant trend in increased sugar content as the de-vining period was extended in comparison to the day 0 control.

**Results 2010.** There were no significant differences in sucrose, fructose, glucose, or maltose (Fig. 3.15). Total sugar content for day 1 was significantly higher in comparison to day 2.

**Results 2011.** There were no significant differences between days in any of the types of sugars (Fig.3.16).



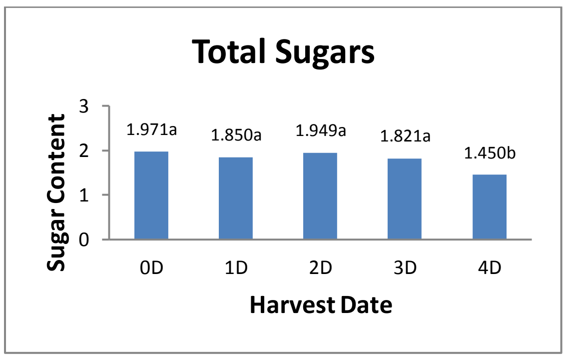




Figure 3.11. Sucrose, maltose, and total sugar content of the fried early harvested Evangeline variety shown by 0 day (0D), 1 day (1D), 2 days (2D), 3 days (3D), and 4 days (4D) after de-vining before harvest for 2010. Different letter designations between columns on a given harvest day represent significant differences at P=0.05. Sugar contents are represented in milligrams per gram of fresh weight.

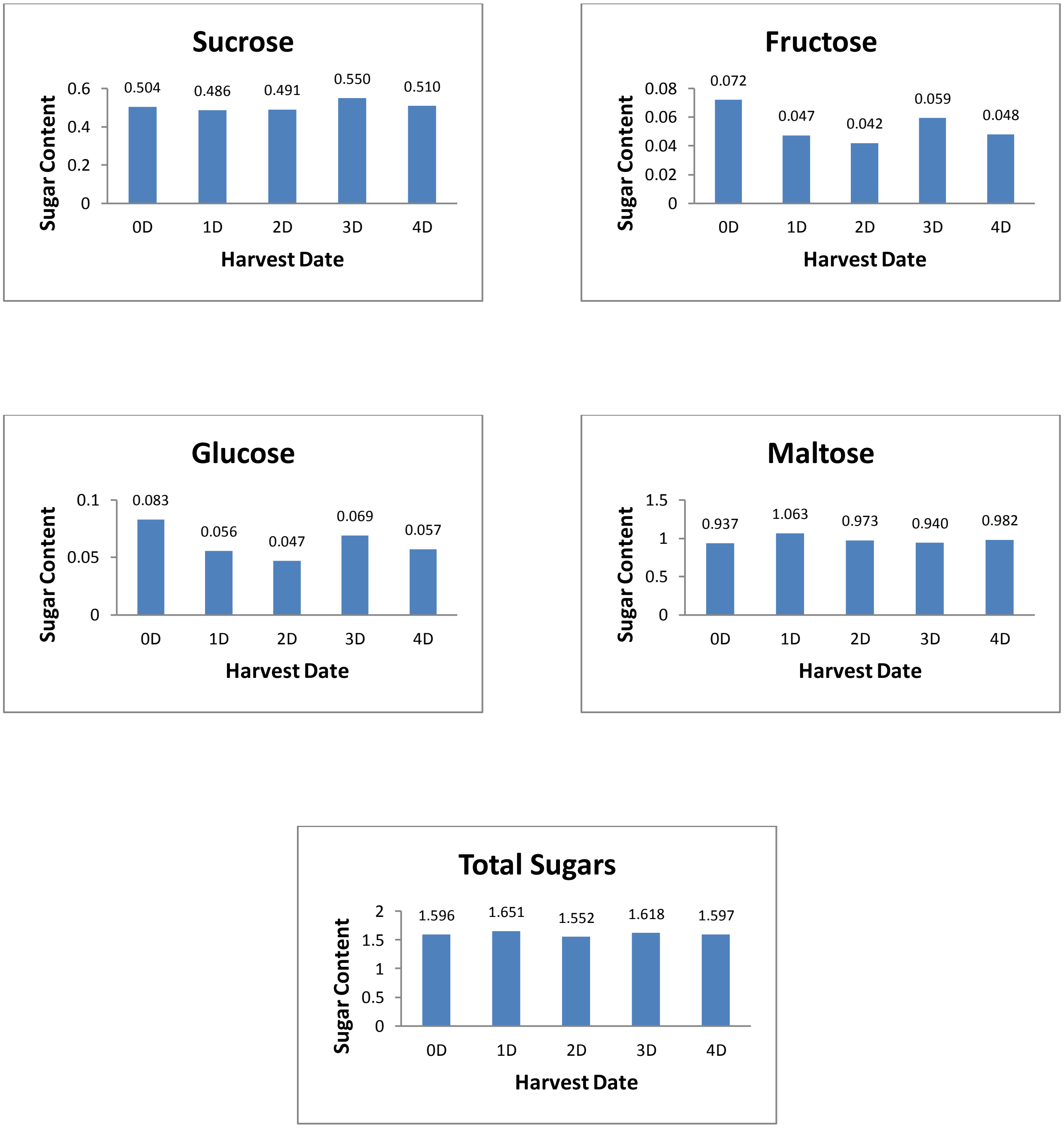



Figure 3.12. Sucrose, maltose, and total sugar content of the fried early harvested Evangeline variety shown by 0 day (0D), 1 day (1D), 2 days (2D), 3 days (3D), and 4 days (4D) after de-vining before harvest for 2011. Different letter designations between columns on a given harvest day represent significant differences at P=0.05. Sugar contents are represented in milligrams per gram of fresh weight.

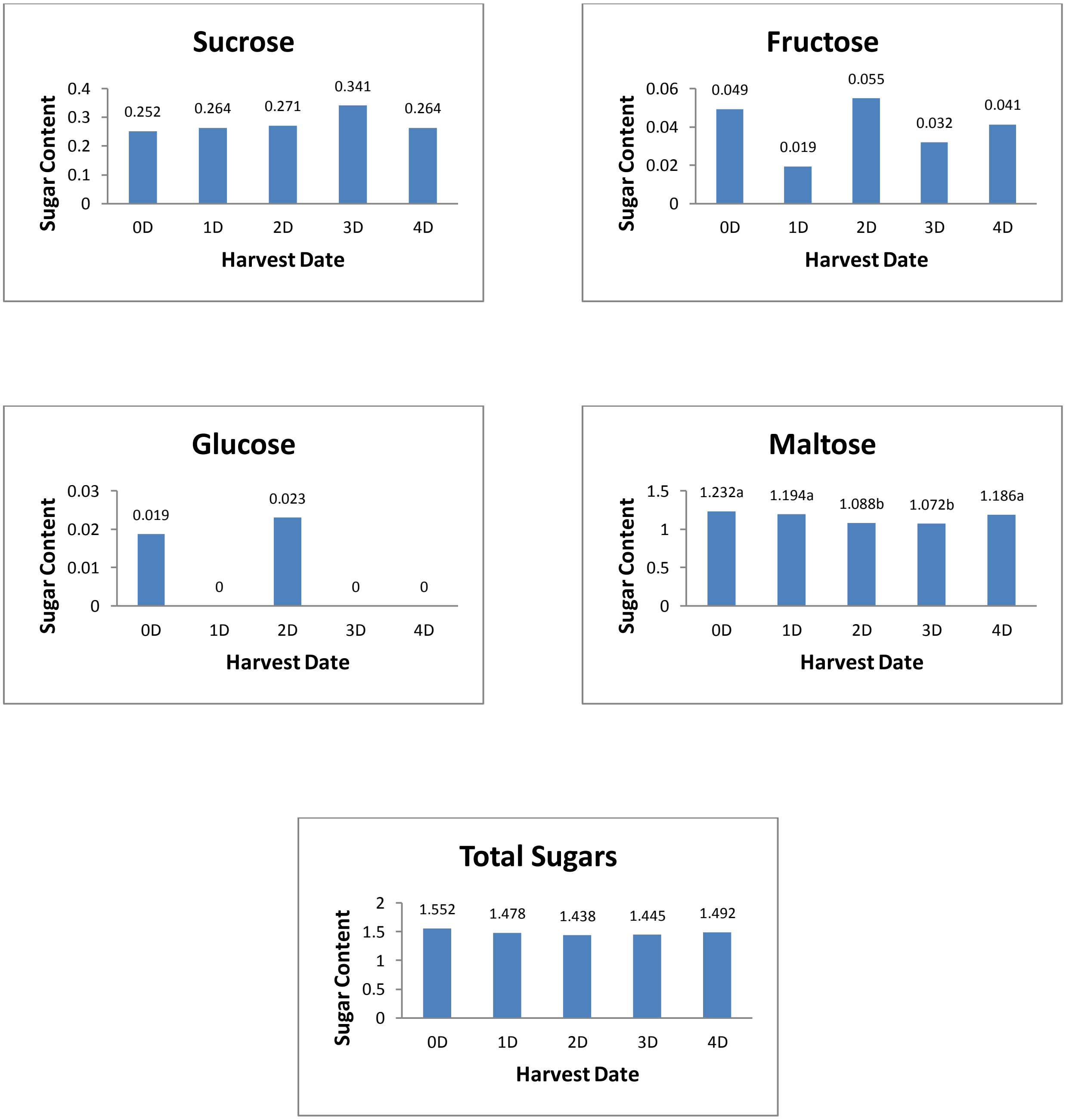
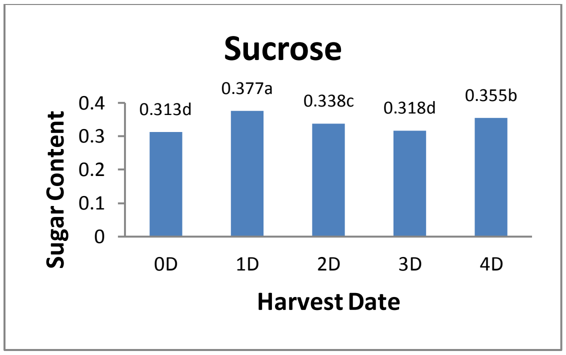
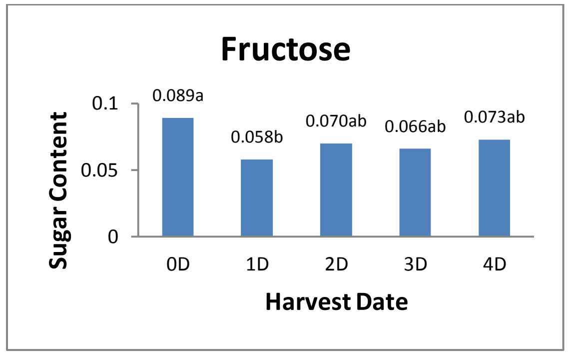
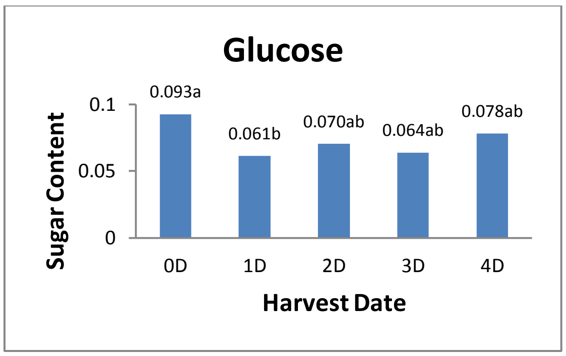
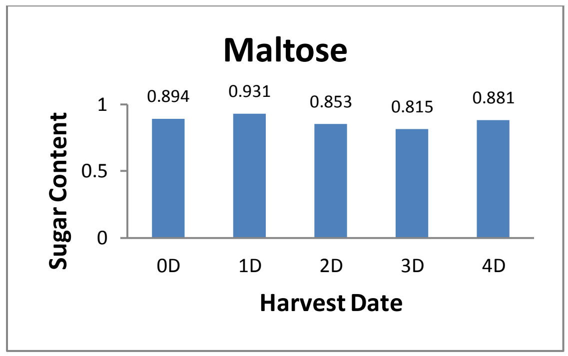



Figure 3.13. Sucrose, fructose, glucose, maltose, and total sugar content of the fried late harvested Beauregard variety shown by 0 day (0D), 1 day (1D), 2 days (2D), 3 days (3D), and 4 days (4D) after de-vining before harvest for 2010. Different letter designations between columns on a given harvest day represent significant differences at P=0.05. Sugar contents are represented in milligrams per gram of fresh weight.



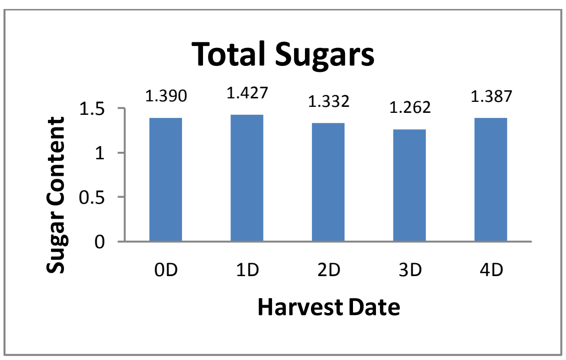




Figure 3.14. Sucrose, fructose, glucose, maltose, and total sugar content of the fried late harvested Beauregard variety shown by 0 day (0D), 1 day (1D), 2 days (2D), 3 days (3D), and 4 days (4D) after de-vining before harvest for 2011. Different letter designations between columns on a given harvest day represent significant differences at P=0.05. Sugar contents are represented in milligrams per gram of fresh weight.

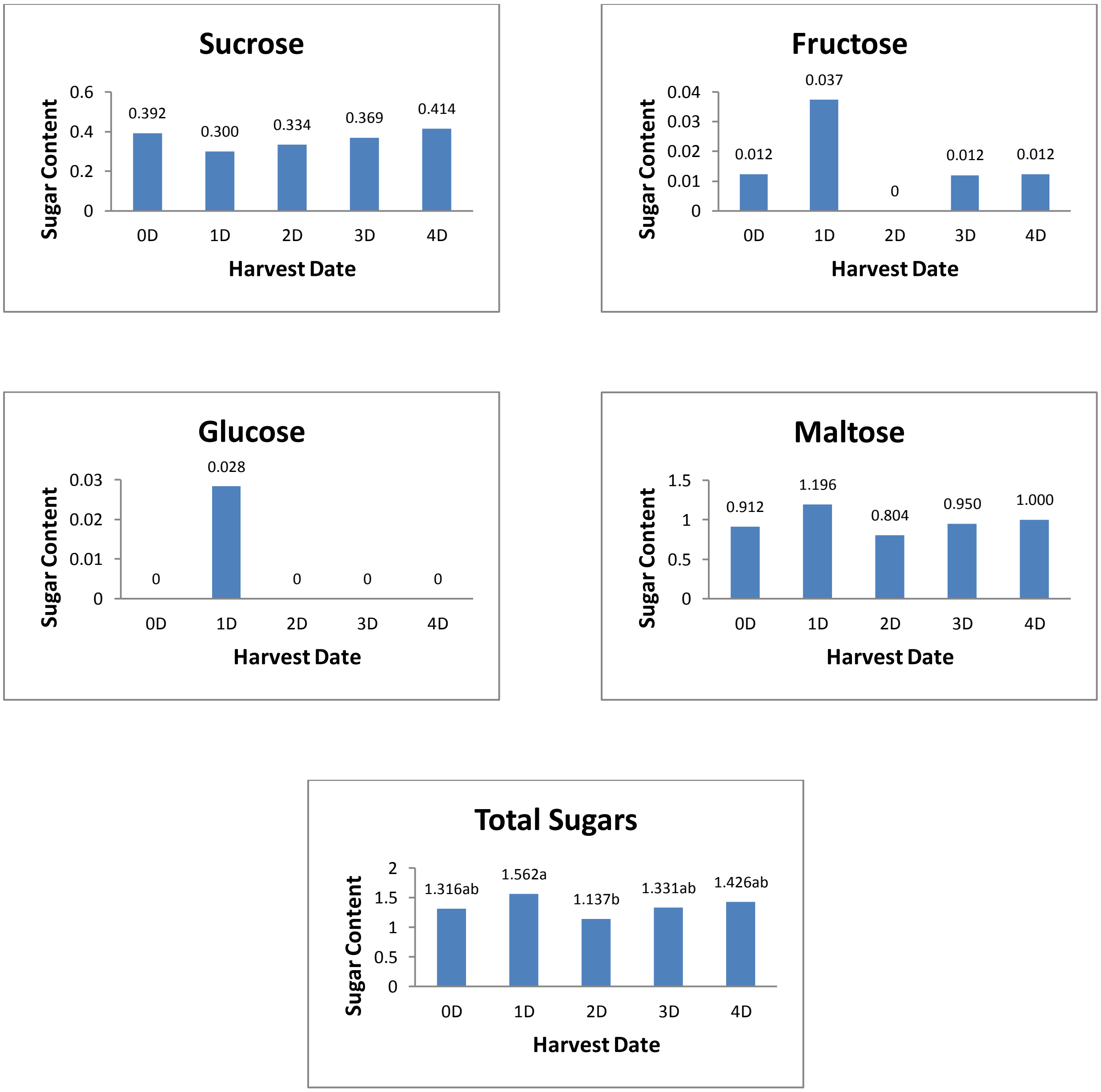



Figure 3.15. Sucrose, fructose, glucose, maltose, and total sugar content of the fried late harvested Evangeline variety shown by 0 day (0D), 1 day (1D), 2 days (2D), 3 days (3D), and 4 days (4D) after de-vining before harvest for 2010. Different letter designations between columns on a given harvest day represent significant differences at P=0.05. Sugar contents are represented in milligrams per gram of fresh weight.

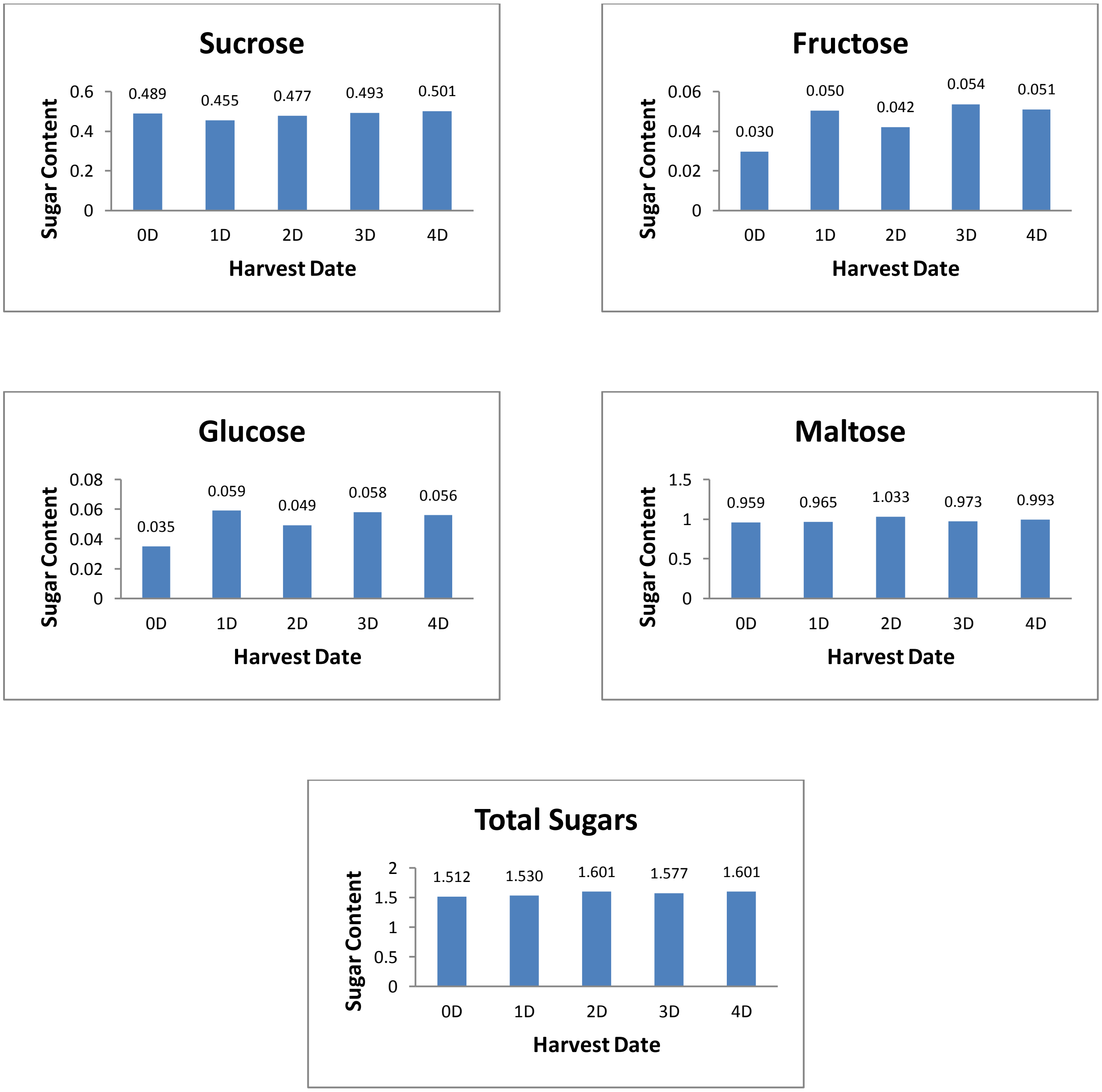



Figure 3.16. Sucrose, fructose, glucose, maltose, and total sugar content of the fried late harvested Evangeline variety shown by 0 day (0D), 1 day (1D), 2 days (2D), 3 days (3D), and 4 days (4D) after de-vining before harvest for 2011. Different letter designations between columns on a given harvest day represent significant differences at P=0.05. Sugar contents are represented in milligrams per gram of fresh weight.

### 3.4 Discussion

Previous curing studies have shown that sweetpotatoes can be cured at 30-32°C at 90-95% relative humidity for 4 to 10 days. Roots demonstrated a sharp increase in sucrose and total sugars in that 4 to 10 day period and, as storage time increases up to a year, there is a steady increase in sugars as well (Picha, 1987). This experiment was designed to eliminate a curing room for sugar enhancement in hopes that, when the vines are cut, the curing process might initiate while the roots are still in the ground before harvest. A previous experiment has been performed to test for skinning resistance of roots as the de-vining period was extended. These results showed that as the de-vining period was extended, the skinning resistance was increased (LaBonte and Wright, 1993). The vines were removed at ground level 0, 4, 8, and 10 days preharvest. Skinning damage was reduced 62% when the vines were removed 10 days prehavest, 53% at 8 days, and 26% at 4 days when compared to the 0 day control. Another such study showed no further significant reduction in skinning when vines were removed 15 days preharvest (LaBonte and St. Amand, 1989). The positive attribute of wound healing that is realized by curing might be similar to the process that occurs when the early de-vining results in skinning resistance. Thus the hypothesis that sugar content might increase as the de-vining period increases is reasonable. Storage roots with higher sugar content and lessened skinning would be significant to the industry and alter production practices. The original hypothesis was based on the assumption that ambient weather conditions could mimic that of the curing environment, and then it could be possible to cure in the field. Typical prime harvest season in Louisiana would supply a similar environment to that of the one required for proper curing. The September air temperatures recorded at Chase, LA (Tables 3.1 and 3.3) for the two years in which this study was conducted were high enough (32-35°C) to suffice for this curing environment. The temperatures (18-27°C) for the later November harvest were lower (Tables

3.2 and 3.4) and were expected to have lesser effect in curing in the field. Soil temperatures were much lower than the air temperatures in all harvests except for the early September harvest in 2010 and never exceeded 32°C (Table 3.1).

Results ran counter to expectations. There were no real trends in an increase in any of the sugars as the de-vining period was increased. Though there were significant differences between days in many of the sugars, there were no clear trends. Many times these differences were attributed to maltose which became abundant in the samples after they were cooked. The amount of maltose is much higher in percentage than all the other sugars after cooking (Picha, 1985). This, in turn, affected the total sugar content. In many cases if the maltose contents were found to be significantly different between days then this was also true for the total sugar content. Fructose and glucose are minor sugars and although, statistically significant at times in the present work, never contribute to total sugars (Picha 1987). Our results also showed sugar trends for two very different varieties. Evangeline is considered to be a high sucrose/high total sugar variety compared to Beauregard (LaBonte *et al.*, 2008). Both showed a similar response to field curing.

**3.5 Conclusions**

Results showed no clear trends that any of the treatments could be used to increase sugar content by field curing. Though there were a few treatments which demonstrated a trend towards higher sugar content as the de-vining period was increased, it was not prominent, nor consistent enough to recommend a certain de-vining schedule to increase sugar contents. Further research might be considered to test to see if the complete necrosis of vines might be advantageous toward higher sugar contents. The possibility of spraying the vines with a quick burndown spray such as paraquat might completely kill the vine so the root no longer relies on the vine for photosynthesis. This would add another element which would make the environment more comparable to storage building curing. The same could be said of using some type of plow or blade to run below the soil surface and detach the roots from the feeder roots physically. Either of these practices would mean a new cost incurred and would need to be compared to traditional curing and price differential supported by the processor.

**3.6 Literature Cited**

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## APPENDIX:

## STATISTICAL ANALYSES

### Root Yields

The following code is used in the optimization of root yield experiment. This code is representative of the 2011 yield analysis.

```
dm 'log;clear;output;clear';
data spacing study;
input variety $ varietyx $ rep spacing width ones canners jumbo onesjumbo
factor30 PDate $ HDate $;
total=ones+canners+jumbo;
factor=factor30;
ones1=ones*factor;
canners1=canners*factor;
jumbo1=jumbo*factor;
onesjumbo1=onesjumbo*factor;
total1=total*factor;
cards;
Bx Bx12b42d 1 12 42 7 6.5 0 7 18.6695 b LL
Bx Bx12b42d 2 12 42 20 14 0 20 18.6695 b LL
Bx Bx12b42d 3 12 42 17 18 0 17 18.6695 b LL
Bx Bx12b42d 4 12 42 30 7.5 0 30 18.6695 b LL
Bx Bx16b42d 1 16 42 17 9.5 8.5 25.5 18.6695 b LL
Bx Bx16b42d 2 16 42 14 9 1.5 15.5 18.6695 b LL
Bx Bx16b42d 3 16 42 13.5 18 0 13.5 18.6695 b LL
Bx Bx16b42d 4 16 42 25 17 1 26 18.6695 b LL
Ev Ev12b42d 1 12 42 9 7 0 9 18.6695 b LL
Ev Ev12b42d 2 12 42 3.5 8 0 3.5 18.6695 b LL
Ev Ev12b42d 3 12 42 5.5 5.5 0 5.5 18.6695 b LL
Ev Ev12b42d 4 12 42 19 10 0 19 18.6695 b LL
Ev Ev16b42d 1 16 42 14 3 0 14 18.6695 b LL
Ev Ev16b42d 2 16 42 13 10 0 13 18.6695 b LL
Ev Ev16b42d 3 16 42 8 7 0 8 18.6695 b LL
Ev Ev16b42d 4 16 42 15 3 1.5 16.5 18.6695 b LL
Bx Bx12a42b 1 12 42 41 21 9 50 18.6695 a EL
Bx Bx12a42b 2 12 42 63 17 8 71 18.6695 a EL
Bx Bx12a42b 3 12 42 39 19 13 52 18.6695 a EL
Bx Bx12a42b 4 12 42 17 26 1 18 18.6695 a EL
Bx Bx16a42b 1 16 42 48 13 6 54 18.6695 a EL
Bx Bx16a42b 2 16 42 56 11 0 56 18.6695 a EL
Bx Bx16a42b 3 16 42 31 23 6 37 18.6695 a EL
Bx Bx16a42b 4 16 42 53 10 5 58 18.6695 a EL
Ev Ev12a42b 1 12 42 29 22 2 31 18.6695 a EL
Ev Ev12a42b 2 12 42 38 18 0 38 18.6695 a EL
Ev Ev12a42b 3 12 42 37 31 3 40 18.6695 a EL
Ev Ev12a42b 4 12 42 23 28 12 35 18.6695 a EL
Ev Ev16a42b 1 16 42 40 20 7 47 18.6695 a EL
Ev Ev16a42b 2 16 42 63 19 8 71 18.6695 a EL
Ev Ev16a42b 3 16 42 25 21 0 25 18.6695 a EL
Ev Ev16a42b 4 16 42 23 23 6 29 18.6695 a EL
Bx Bx12b42c 1 12 42 17.5 15 0 17.5 18.6695 b LE
```

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Bx Bx12b42c 2 12 42 36 28 0 36 18.6695 b LE
Bx Bx12b42c 3 12 42 26 19.5 0 26 18.6695 b LE
Bx Bx12b42c 4 12 42 26.5 13.5 5 31.5 18.6695 b LE
Bx Bx16b42c 1 16 42 16 16.5 0 16 18.6695 b LE
Bx Bx16b42c 2 16 42 25 15.5 0 25 18.6695 b LE
Bx Bx16b42c 3 16 42 28.5 14 9.5 38 18.6695 b LE
Bx Bx16b42c 4 16 42 24.5 14 4 29.5 18.6695 b LE
Ev Ev12b42c 1 12 42 15 16 0 15 18.6695 b LE
Ev Ev12b42c 2 12 42 11 15 0 11 18.6695 b LE
Ev Ev12b42c 3 12 42 22 19.5 1.5 23.5 18.6695 b LE
Ev Ev12b42c 4 12 42 17.5 14 0 17.5 18.6695 b LE
Ev Ev16b42c 1 16 42 10.5 14.5 0 10.5 18.6695 b LE
Ev Ev16b42c 2 16 42 19 12 5 24 18.6695 b LE
Ev Ev16b42c 3 16 42 15.5 12 0 15.5 18.6695 b LE
Ev Ev16b42c 4 16 42 19 12.5 2 21 18.6695 b LE
Bx Bx12a42a 1 12 42 49 11 0 49 18.6695 a EE
Bx Bx12a42a 2 12 42 44 17 9 53 18.6695 a EE
Bx Bx12a42a 3 12 42 23 12 0 23 18.6695 a EE
Bx Bx12a42a 4 12 42 28 19.5 0 28 18.6695 a EE
Bx Bx16a42a 1 16 42 44.5 14.5 3.5 48 18.6695 a EE
Bx Bx16a42a 2 16 42 43 10 0 43 18.6695 a EE
Bx Bx16a42a 3 16 42 51 17 3.5 54.5 18.6695 a EE
Bx Bx16a42a 4 16 42 42 9 2 44 18.6695 a EE
Ev Ev12a42a 1 12 42 18.5 14 0 18.5 18.6695 a EE
Ev Ev12a42a 2 12 42 30.5 19 0 30.5 18.6695 a EE
Ev Ev12a42a 3 12 42 23 15 8.5 31.5 18.6695 a EE
Ev Ev12a42a 4 12 42 38 18 5 43 18.6695 a EE
Ev Ev16a42a 1 16 42 45 13 10 55 18.6695 a EE
Ev Ev16a42a 2 16 42 34.5 11.5 5.5 40 18.6695 a EE
Ev Ev16a42a 3 16 42 14.5 11 0 14.5 18.6695 a EE
Ev Ev16a42a 4 16 42 21 15 6 27 18.6695 a EE
Bx Bx12a38a 1 12 38 32 11 2 34 20.634 a EE
Bx Bx12a38a 2 12 38 35 7 0 35 20.634 a EE
Bx Bx12a38a 3 12 38 25 15 0 25 20.634 a EE
Bx Bx12a38a 4 12 38 26 13.5 6.5 32.5 20.634 a EE
Bx Bx16a38a 1 16 38 19 11 0 19 20.634 a EE
Bx Bx16a38a 2 16 38 35 8 0 35 20.634 a EE
Bx Bx16a38a 3 16 38 30.5 8 5 35.5 20.634 a EE
Bx Bx16a38a 4 16 38 58 9 3 61 20.634 a EE
Ev Ev12a38a 1 12 38 8 15 7 15 20.634 a EE
Ev Ev12a38a 2 12 38 12 11 3 15 20.634 a EE
Ev Ev12a38a 3 12 38 38 15 10 48 20.634 a EE
Ev Ev12a38a 4 12 38 28 14 10 38 20.634 a EE
Ev Ev16a38a 1 16 38 25 16 0 25 20.634 a EE
Ev Ev16a38a 2 16 38 21 12 10 31 20.634 a EE
Ev Ev16a38a 3 16 38 25 15 0 25 20.634 a EE
Ev Ev16a38a 4 16 38 15 12 3 18 20.634 a EE
Bx Bx12a38b 1 12 38 44 9 0 44 20.634 a EL
Bx Bx12a38b 2 12 38 48 18 0 48 20.634 a EL
Bx Bx12a38b 3 12 38 18 17 5 23 20.634 a EL
Bx Bx12a38b 4 12 38 43 12 12 55 20.634 a EL
Bx Bx16a38b 1 16 38 25 15 0 25 20.634 a EL
Bx Bx16a38b 2 16 38 35 20 0 35 20.634 a EL
Bx Bx16a38b 3 16 38 56 14 13 69 20.634 a EL
Bx Bx16a38b 4 16 38 48 10 15 63 20.634 a EL
Ev Ev12a38b 1 12 38 19 23 0 19 20.634 a EL
Ev Ev12a38b 2 12 38 29 18 0 29 20.634 a EL
Ev Ev12a38b 3 12 38 34 20 12 46 20.634 a EL
```

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Ev Ev12a38b 4 12 38 45 16 17 62 20.634 a EL
Ev Ev16a38b 1 16 38 32 18 9 41 20.634 a EL
Ev Ev16a38b 2 16 38 43 8 0 43 20.634 a EL
Ev Ev16a38b 3 16 38 37 18 5 42 20.634 a EL
Ev Ev16a38b 4 16 38 28 13 0 28 20.634 a EL
Bx Bx12b38c 1 12 38 16 13 0 16 20.634 b LE
Bx Bx12b38c 2 12 38 18 18 0 18 20.634 b LE
Bx Bx12b38c 3 12 38 9.5 14 0 9.5 20.634 b LE
Bx Bx12b38c 4 12 38 16 11 3 19 20.634 b LE
Bx Bx16b38c 1 16 38 7 13 0 7 20.634 b LE
Bx Bx16b38c 2 16 38 12 12.5 1.5 13.5 20.634 b LE
Bx Bx16b38c 3 16 38 24 11 5 19 20.634 b LE
Bx Bx16b38c 4 16 38 5 11 0 5 20.634 b LE
Ev Ev12b38c 1 12 38 10 11.5 0 10 20.634 b LE
Ev Ev12b38c 2 12 38 6 13 0 6 20.634 b LE
Ev Ev12b38c 3 12 38 9 13 0 9 20.634 b LE
Ev Ev12b38c 4 12 38 15 15.5 3 18 20.634 b LE
Ev Ev16b38c 1 16 38 13.5 9.5 0 13.5 20.634 b LE
Ev Ev16b38c 2 16 38 6 11 0 6 20.634 b LE
Ev Ev16b38c 3 16 38 9 12.5 0 9 20.634 b LE
Ev Ev16b38c 4 16 38 5.5 9 0 5.5 20.634 b LE
Bx Bx12b38d 1 12 38 20 7 15 35 20.634 b LL
Bx Bx12b38d 2 12 38 18 14 1 19 20.634 b LL
Bx Bx12b38d 3 12 38 13.5 14 0 13.5 20.634 b LL
Bx Bx12b38d 4 12 38 24 5 0 24 20.634 b LL
Bx Bx16b38d 1 16 38 13 13 3 16 20.634 b LL
Bx Bx16b38d 2 16 38 10.5 10 1 11.5 20.634 b LL
Bx Bx16b38d 3 16 38 8 15 0 8 20.634 b LL
Bx Bx16b38d 4 16 38 26.5 5 0 26.5 20.634 b LL
Ev Ev12b38d 1 12 38 15.5 14.5 0 15.5 20.634 b LL
Ev Ev12b38d 2 12 38 0 7.5 0 0 20.634 b LL
Ev Ev12b38d 3 12 38 3.5 10 0 3.5 20.634 b LL
Ev Ev12b38d 4 12 38 5.5 9 0 5.5 20.634 b LL
Ev Ev16b38d 1 16 38 10 10 0 10 20.634 b LL
Ev Ev16b38d 2 16 38 7 5.5 1 8 20.634 b LL
Ev Ev16b38d 3 16 38 3.5 8.5 0 3.5 20.634 b LL
Ev Ev16b38d 4 16 38 8.5 3 0 8.5 20.634 b LL
;
proc glm;
class variety width spacing HDate ones1;
model ones1 canners1 jumbo1 onesjumbo1 total1 = variety | width | spacing |
HDate ;
means variety/duncan alpha=0.05;
means width/duncan alpha=0.05;
means spacing/duncan alpha=0.05;
means HDate/duncan alpha=0.05;
run;
quit;
/*variety | width | spacing |*/
```

## Sugar Analysis

The following code is used in the de-vining period experiment. All treatments were run separately. This code is representative of the fried late Beauregard product.

```
dm 'log;clear;output;clear';
data Bx FL;
input day $ rep sucrose fructose glucose maltose;
total=sucrose+fructose+glucose+maltose;
cards;
4D    3           0.377 0.02  0     0
3D    3           0.333 0.037 0.035 0
2D    3           0.304 0.02  0.017 0
1D    3           0.326 0.019 0.02  0
0D    3           0.317 0.037 0.037 0
4D    2           0.348 0.026 0.024 0
3D    2           0.309 0.022 0.023 0
2D    2           0.295 0.012 0     0
1D    2           0.336 0.021 0.019 0
0D    2           0.26  0.024 0.019 0
4D    1           0.3   0.021 0.02  0
3D    1           0.319 0.016 0.018 0
2D    1           0.315 0.013 0     0
1D    1           0.309 0.015 0.012 0
0D    1           0.32  0.035 0.037 0

;
proc glm;
class rep day;
model sucrose fructose glucose maltose total = rep day;
means day/duncan E=rep;
lsmeans day;
run;
```

## VITA

Cody Smith was born in Decatur, Alabama as the middle child of Keith and Wilma Smith. Raised in Cullman, Alabama, Cody graduated from Fairview High School in 2006 and then went on to complete a Bachelor of Science in Agronomy and Soils at Auburn University in December of 2009. Currently working under the direction of Dr. Don LaBonte, Cody is a candidate for the degree of Master of Science in Plant, Environmental, and Soil Sciences with a research emphasis on cultural practices of sweetpotato. After completing his degree, he will be returning to Cullman to help his father and brother on their family farm where they, in fact, grow sweetpotatoes.