Evaluating the Bioethanol Potential of Industrial Sweetpotatoes in Florida

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Abstract

Sweetpotato (*Ipomoea batatas* L.) is a starch-based crop that can be used for human consumption or biofuel production. The decision on whether to grow sweetpotatoes for food, fuel or manufactured products depends on the needs of the surrounding community. In Florida, an industrial sweetpotato variety (CX-1) is being considered as an alternative crop for citrus lost to greening. The CX-1 was selected for fuel ethanol production because of its large roots with high dry matter (DM) and elevated starch content. A field trial was conducted in Gainesville, Florida to determine the agronomic yields and corresponding starch yields of the CX-1. Rooted versus unrooted sweetpotato vine material was planted in raised beds, with three replications for each material type. Rooted plants were established in trays for 30 days prior to planting while unrooted cuttings were stripped from recently harvested vines and planted directly in the ground. Both plots were harvested 182 days after planting and weighed to determine agronomic yields. Roots were processed into flour immediately following harvest and also after six months of storage and then analyzed for total starch content. The agronomic root yields (DM basis) of the rooted and unrooted CX-1 crop were 3.1 and 1.8 tons/acre, respectively. The starch content of the rooted crop was also higher (71.2% DM) than the unrooted crop (68.5% DM), producing an overall starch yield of 2.2 tons/acre. No significant loss in starch was observed after storage suggesting that this crop could be utilized year-round as a feedstock for ethanol production.

Introduction

- Sweetpotatoes are a promising feedstock for bioethanol production because they require minimal irrigation and fertilization
- Sweetpotatoes grown for ethanol production are generally drier with higher starch and less sugar contents than table varieties
- Industrial sweetpotatoes can exceed the starch and ethanol yields of corn (see Table 1)

Table 1. Yields of Sweetpotatoes vs Field Corn[1]

Feedstock	Starch (t/ac)	Ethanol (L/ac)
Sweetpotato (Maryland)	3.50	3579
Field Corn (Maryland)	2.18	1376

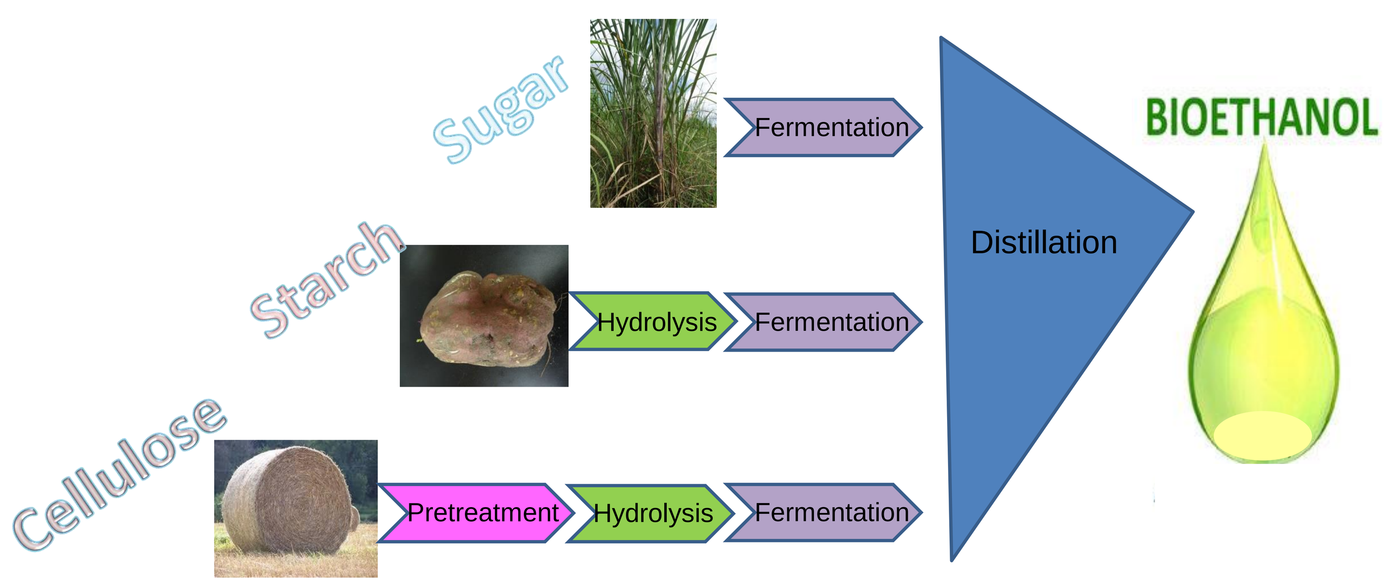

Figure 1. Feedstocks for Bioethanol Production

Objectives

- **Conduct field trials to determine agronomic yield of CX-1 root in Florida soils**
- **Measure starch content to determine starch yield per unit land area and storage efficiency**
- **Determine bioethanol potential of CX-1 sweetpotato**

Methods

- Conducted field trials to determine agronomic yields of CX-1 storage roots
  - Planted 126 rooted plants after establishing in trays for 30 days
  - Planted 126 unrooted cuttings
  - Harvested, graded, and weighed all roots by hand 182 days after planting (DAP) in the ground
- Measured starch content of roots immediately and after six months
  - Chopped, oven-dried (60°C for 72 hr) and ground samples to pass through a 0.5mm mesh
  - Performed starch assay with Megazyme total starch kit (KTSTA)
- Determined bioethanol yield
  - Converted roots into ethanol at the National Corn Ethanol Research Center (NCERC)

Rooted Versus Unrooted Plants

Jumbo Roots Harvested From Rooted Plot

Culls, Rootlets and Petites Harvested From Unrooted Plot

Results

Table 2. Agronomic Yield of CX-1 Roots

Parameter	Rooted Plot	Unrooted Plot
Dry matter (% fresh wt)	28.0 ± 0.2	21.2 ± 0.8
Fresh matter yield (t/ac)	11.1	8.5
Dry matter yield (t/ac)	3.1	1.8

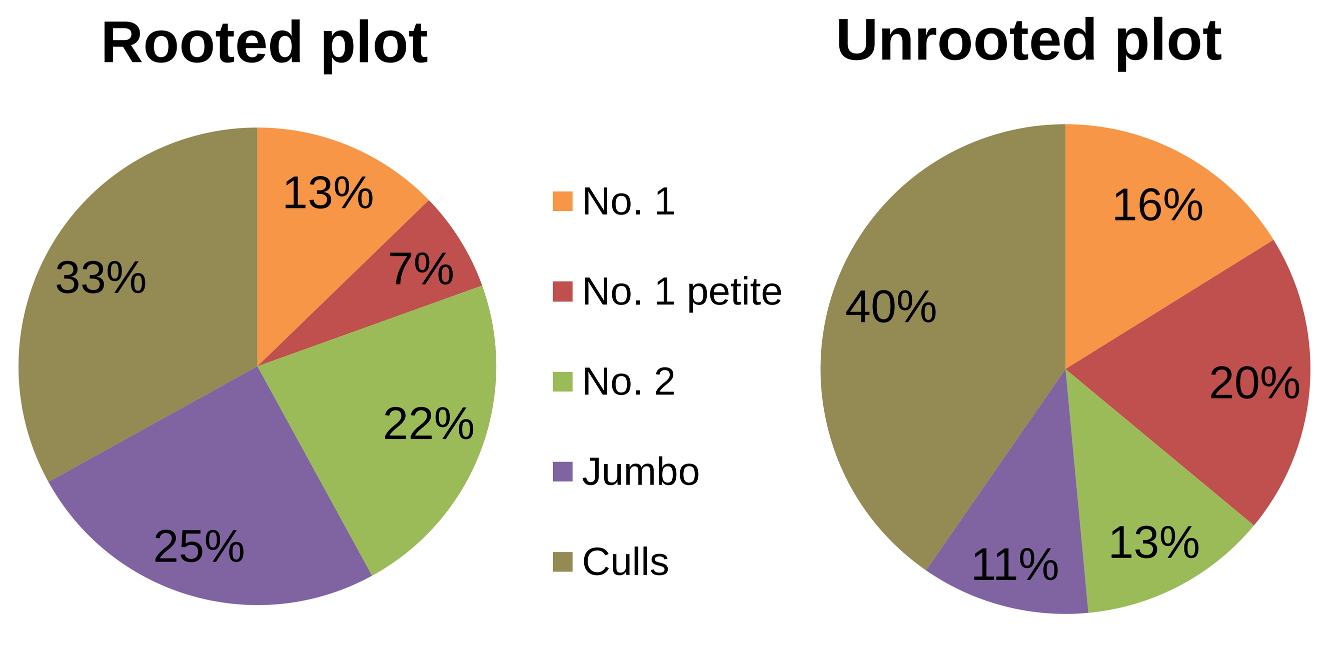

Figure 2. Grading Distribution of CX-1 Roots

The planting strategy of rooted verses unrooted cuttings improved the agronomic yield by nearly 70% (on a DM basis) and also produced a much higher proportion of Jumbo-sized roots. The cull rate (rotten or diseased roots) was also lower in the rooted plot (33%) compared to the unrooted plot (40%).

Results (cont.)

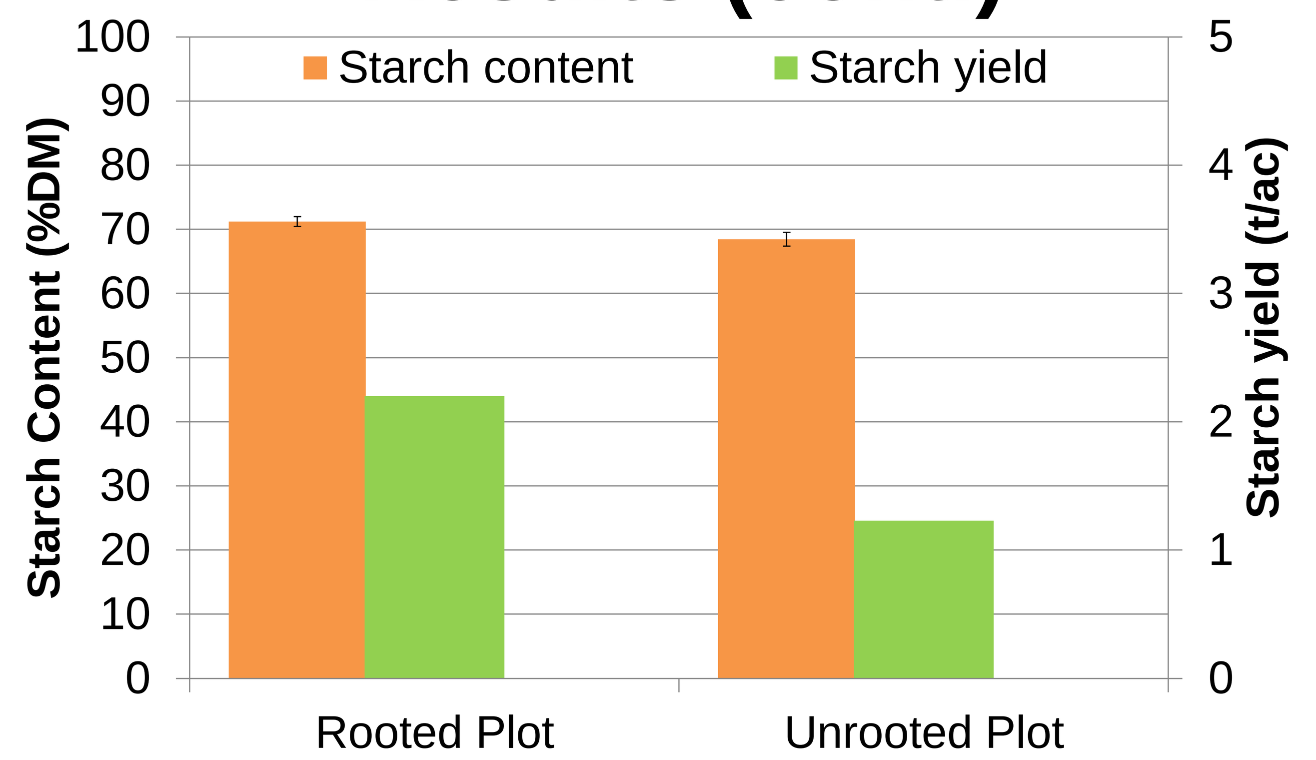

Figure 3. Starch Content and Yield from CX-1 Roots

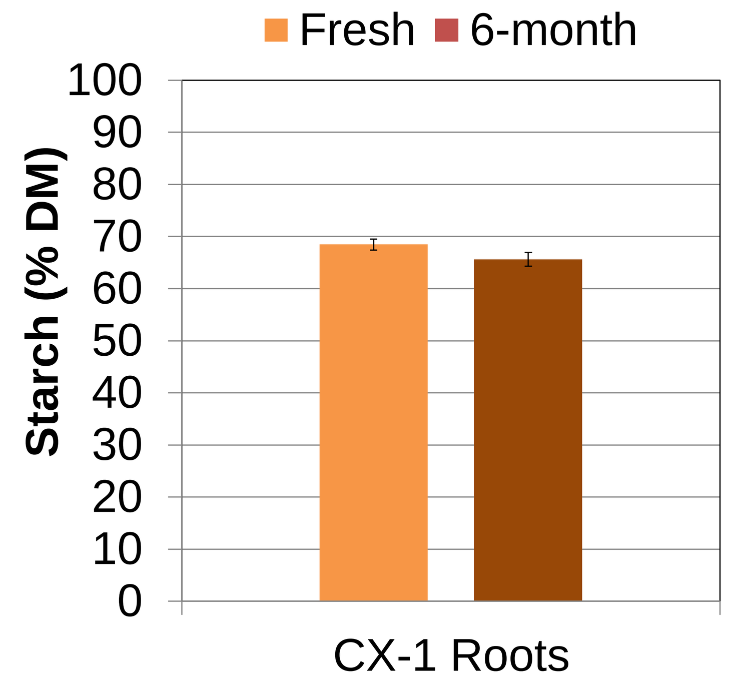

Figure 4. Starch Content at Harvest and 6 months

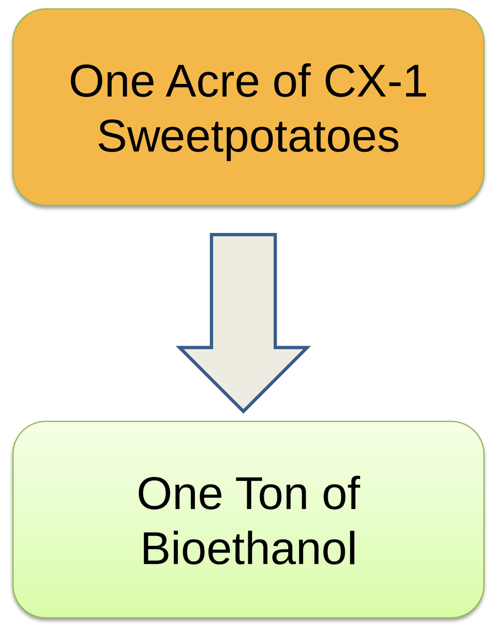

Figure 5. Bioethanol Yield from CX-1

The starch content from the CX-1 exceeded the starch content of other industrial varieties grown in the Southeastern United States [2,3] as well as those selected from the World Gene Bank for starch production [4]. The CX-1 root maintained its high starch content even after six months of storage. The fermentation process resulted in 0.34 gEtOH/g dry CX-1, which results in an agronomic yield of 1 ton EtOH per acre.

Conclusions

- Planting strategy of rooted versus unrooted cuttings improved agronomic yield, size, quality (*i.e.* less culls) and starch content of the CX-1 roots
- Storage of the CX-1 roots for six months resulted in minimal loss of starch, suggesting the CX-1 roots could be used as a year-round feedstock for ethanol production
- Agronomic bioethanol yield from CX-1 is 1 ton of ethanol per acre

References

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[2] Jones, A., Hamilton, M. G., & Dukes, P. D. (1983). Sweet potato cultivars for ethanol production. Paper presented at the Third Annual Solar and Biomass Workshop, Atlanta, GA on April 26-28, 1983.

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Acknowledgements

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