

The Innovation

A novel biosynthetic pathway that increases biomass and fermentable sugars has been introduced into beets to increase biofuel per acre

Why Beets?



High biofuel/bio-product yield per acre

Low fertilizer and water requirement

Low greenhouse gas emissions

Wide geographic potential

Readily fermentable sugars (no pretreatment required)

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ARPA-E project

Development of
High-Output,
Low-Input
Energy Beets



Plant
Sensory Systems

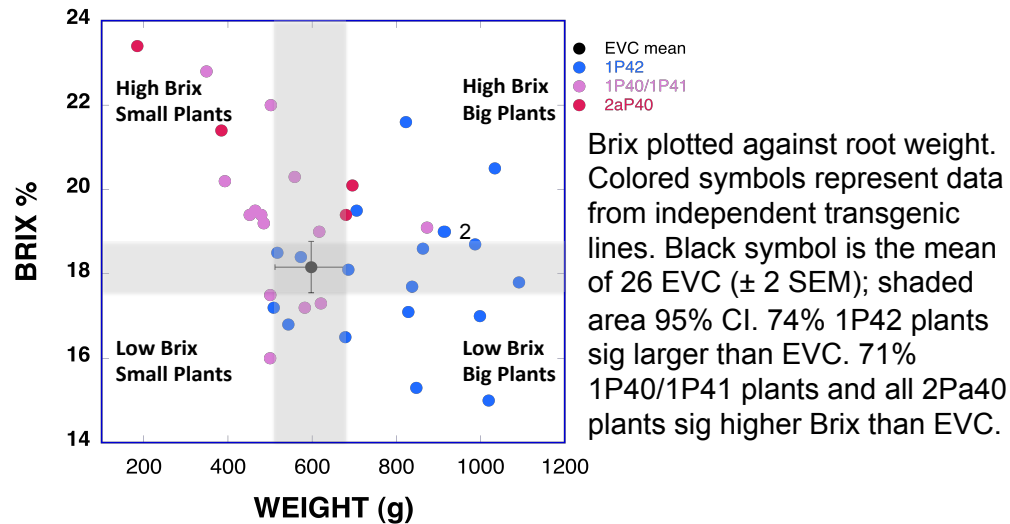
NDSU

PROGRESS

Three different promoter/gene cassettes with the NUEST technology and an empty vector cassette were independently transformed into beet. Thirty-seven (37) plants with the NUEST technology* and 26 age-matched empty vector controls (EVC) were harvested to assess sugar content (Brix) and root size (weight).

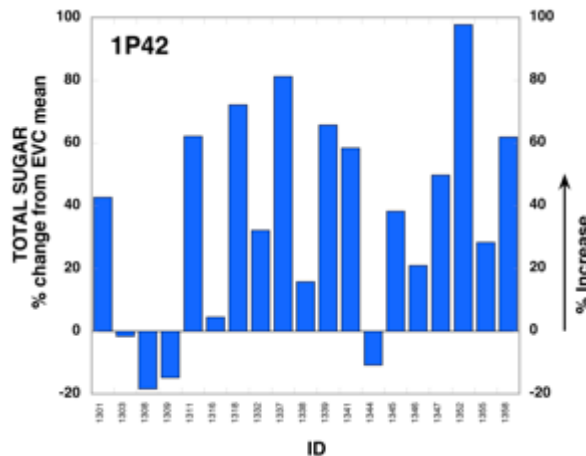
*GFP, PCR and immunoblot positive

Brix and Root Weight



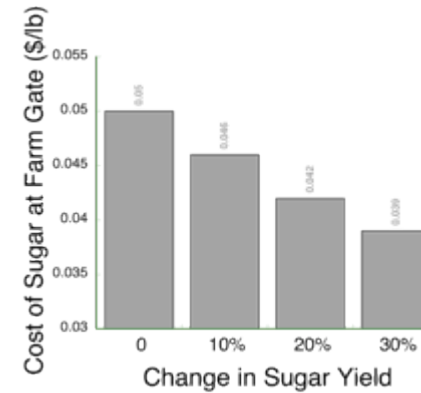
Significantly More Sugar

Change (%) in total sugar per plant (Brix x root weight) is shown for each 1P42 plant relative to the EVC mean (0%). Note that 79% (15/19) of the 1P42 plants have higher total sugar relative to EVC. The mean change in total sugar for the 1P42 plants is +36%. The maximum level of change is almost a doubling (+98%).



BENEFITS OF NUEST TECHNOLOGY

Lower Sugar Costs



Feedstock production cost (per lb of sugar) at various levels of increased sugar yield. Note that a 30% increase in sugar content reduces the cost of sugar at farm gate by 20% (from \$0.05 to \$0.039/lb).

Higher Profits for Ethanol Production (per gallon of gasoline)

Increase in Sugar	California (CA)		North Dakota (ND)		Southeast (SE)
	San Joaquin Valley	Imperial Valley	Dryland	Irrigated	
0	\$0.06	\$0.05	\$0.33	\$0.14	\$0.88
10%	\$0.20	\$0.17	\$0.44	\$0.27	\$1.01
20%	\$0.33	\$0.30	\$0.55	\$0.40	\$1.09
30%	\$0.46	\$0.43	\$0.66	\$0.53	\$1.16

Lower Carbon Intensity (CI)

The carbon intensity (CI) for corn is 65.46 gCO₂e/MJ. For conventional beets, the CI ranges across the US from 51.83 to 46.29 gCO₂e/MJ. A 30% increase in sugar content reduces the CI across all regions by 16%, resulting in CI levels that would meet the CI requirement of advanced biofuel status* (dashed line).

*50% reduction in petroleum-fuel CI baseline (96.24 gCO₂e/MJ). Estimates do not consider land-use change.

