

Triple-Crop Sugar Corn Yields Sugar, Grain, And Biomass With Less Nitrogen

URBANA, ILL.
By crossing maize plants adapted to the tropics with lines used as parents of popular Midwestern corn hybrids, researchers at the University of Illinois have developed a new type of plant with the potential to yield three crops and use less nitrogen. Sugar corn can be harvested for the grain, the sugar inside the stalk, and for biomass to produce energy.

Crop scientist Fred Below and plant geneticist Stephen Moose wanted to develop a corn plant that would produce competitive amounts of biomass while using less nitrogen.

“Nitrogen is a big cost for farmers and there are environmental issues, so we wanted to be able to reduce the nitrogen needed, while increasing the biomass,” Moose said.

Moose and Below recognized that there is a lot of interest in growing switchgrass and miscanthus as alternative fuel sources, but more research needs to be done to make it a viable crop choice for Midwest farmers who are currently growing corn.

“If you’re going to grow miscanthus for biomass, we thought, well, what about corn?” Moose said. “We found that the amount of nitrogen needed for efficient biomass production is a lot less than growing it as a grain crop. So, you can get more tons per acre of total biomass with less nitrogen by growing these kinds of lines.”

Moose explained that these tropical temperate hybrids have delayed flowering and greatly reduced seed set, yet still accumulate a lot of carbon—sugar basically — and no where to go with it because it has been programmed to put it in the ear. “So, a key thing about what we did is that we crossed the tropical line with a line that would be grown here — a popular U.S. kind of line. What we’ve done is we’re bringing together the benefits of more than 50 years of intensive breeding for higher grain yields in temperate environments with the delayed flowering effects from the tropical lines, which gives these new varieties the biomass potential — it’s got the best of both.”

Moose said that when you grow these lines in this temperate climate, they have reduced seeds so you get lower yield of grain. But if you go total biomass — the total amount of mass produced per acre, it’s much higher than you would get with a grain crop.

The yields of this new corn, even under low nitrogen, beat the record for switchgrass yields in the Midwest.

“These plants are massive. They have big stalks, and unlike normal corn where stalks become hollow as they supply the grain with nutrients, these corn stalks are all filled up inside with sugar. Our initial observations on small plots during the past few years were promising.

So, in 2008 we expanded the size and locations of our tests for yield of corn grain, sugar and biomass — so that we would have better data for comparison.”

Some varieties of sugar corn have been tested at Illinois research stations in DeKalb and in Dixon Springs and there were big differences. “In the north, the flowering and the maturity suppressed even more. And in the south, it’s less, so you get a lot more grain. They were actually pretty good grain hybrids in Dixon Springs. The days are warmer and slightly shorter there, so it had less of this suppressing seed effect,” Moose said.

Moose concedes that if grain is what you want, sugar corn isn’t the answer. The grain yield from sugar corn might make a suitable livestock feed. “What’s happened over the years in selection for higher grain yield, we’ve worked toward making a plant that’s all grain and produced on a single ear relatively high on the plant so that the combine can easily get it off. But it takes a lot of energy for the plant to make the grain and it actually isn’t as efficient in the big scheme – but obviously, if grain is what you want then that’s what’s done.”

The advantages of sugar corn are the high biomass and the sugar-filled stalk. “Initially, we noticed the high biomass and the sugar increase. The idea is that this corn could be like a temperate sugar cane — that can be grown in non-tropical environments, like the U.S. Corn Belt. So you could grow this as an annual crop and harvest it for its sugar and biomass just like they do in Brazil for sugar cane.”

“If biomass is what you want, then this corn might be better than the corn we currently grow because it needs less nitrogen and it accumulates sugar. If you harvest at the right time, it’s almost like harvesting sugar cane — the amount of sugar in the stalk is like sugar cane.” They calculated that there is six times the amount of sugar in the stalk of this newly developed corn and could produce about 200 gallons of ethanol per acre.

The problem right now is where’s a market for it?

In Brazil, they grow sugar cane to make ethanol and burn the rest for electricity. “There are at least two companies in the United States that are interested in Brazil’s sugar cane model and want to build plants that co-generate ethanol and electricity,” Moose said. “They’re looking at sweet sorghum as their source material and this corn is very much like sweet sorghum.

“But with sugar corn, we could even make a Bt, a Round-up ready version of it. Biotech traits are not yet available for sorghum, and total biomass is probably not as high, because they were developed for the molasses, not the biomass.” Δ



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