Grower of the Month

By Terri Queck-Matzie | Freelance Writer

High-Tech Tubers Take Root in Wisconsin

NASA know-how helps Bula family's minituber production

Good things come in small packages, and the future of the potato industry may rest in a tiny, little minituber.

Minitubers range in size from one-quarter inch to more than one inch in diameter and can be grown in a small space. They also can be grown quickly under environmentally controlled circumstances. And that is exactly what is happening in a simple garage in central Wisconsin.

Controlled Environment Technology Systems (CETS Tech, LLC) is in the process of growing and developing pathogen-free minitubers, called AstroTubers, in a lab near Friendship, Wis. Using space-age science and established methodology, Dr. Ray Bula and associates are perfecting the technology to produce every eight weeks a crop of the minitubers free of tuber-borne disease and insect infestation.

AstroTubers are produced in nine, 4- by 8-foot growth chambers. A computer system with software developed specifically for the project monitors temperature, light and humidity, adjusting for the plants' stage of growth. Young cuttings require low light. At about three weeks, light exposure is increased to facilitate growth. Plants are fed a specialized nutrient solution through an automated delivery system, also controlled by the specially developed software.

Adjustments in all the elements are made for potato variety. The project is currently producing ten varieties of minitubers, including Burbank, Dark Red Norland, Snowden, White Pearls, Norkotah, Shepody, Vanick Russet, Blazer, Pike and Silverton. Some varieties readily adapt to the controlled environment system. Norlands, for example, mature early. Others, like Silverton, can be problematic, as the variety is hard to grow and tends to be a carrier for disease. Bula says the roster of varieties will be adjusted to accommodate grower demand as the project progresses.

The cuttings are taken from mother

Left to right: Elizabeth Bradford, Janina Petrick (partner and CEO of CETSTech, LLC), John Bula, Dr. Ray Bula, Shawn Bula

plants derived from tissue culture plantlets and planted in a sterile rooting material. The chambers allow for isolation from outside contamination.

"We have two levels of defense here," Bula explains. One is the building and the second is the chamber."

That means AstroTubers are grown without exposure to insects and diseases, a primary step to eliminating what can be a major problem for most producers.

According to Bula, the key to reducing the threat of loss of production due to disease is to start with a pathogen-free seedstock. It's a concept that Bula first became familiar with early in his career as a plant biologist for the University of Wisconsin.

"The difference between plants and animals is that plants must endure imposed conditions," says Bula. If an animal encounters an unwanted element, it can move or be moved to avoid it. A plant can't. It's stuck where it's planted and must grow there no matter what." That means it is the environment that must be controlled.

The first step is to plant seed that is free of disease. Working through Wisconsin's Certified Seed Program, Bula hopes to be able to produce that seed. Unlike the "recycled" seedstock used by many producers that can pass viruses and other disease agents from generation to generation, AstroTubers are pathogen free when they leave the lab. The chambers allow for environmental controls above and beyond that afforded by greenhouse growth methods.

From the lab, the minitubers travel to test fields in the Antigo, Wis., area where they are planted and will be field multiplied for two generations.

"Another variable here is whether or not the tubers will sprout," says Bula. So far, the AstroTubers have at least a 99 percent sprouting rate.

The ultimate goal is to produce a source of high-quality certified seed at a competitive price.

"The market drove the development of certified seed and the market will drive the development of pathogen-free seed. It's a simple equation – if you don't produce, you're out of business."
– Shawn Bula of Bula-Geiringer Farms

YEARS OF EXPERIENCE

Bula grew up with his hands in the sandy soil of a potato field. Reared on the family farm in northern Wisconsin, he earned a degree in crop physiology and began researching how plants respond to their environments. The research involved work with the University of Wisconsin's controlled environment chambers.

In the mid 1980s, NASA tapped the UW program to experiment with plants as part of a life-support system on space shuttle missions, a move that led to development of the Plant Generic Bioprocessing Apparatus.

"The trick to growing plants in space is providing water and light," Bula says. Problems with fluids in zero gravity led to development of a mechanical nutrient delivery system.

Lighting proved to be more problematic until Bula and his associates perfected the use of light emitting diodes (LEDs) as a source of radiant energy. But while LEDs are exclusively used in outer space plant production, Bula currently uses florescent lights in his earth-bound growth chambers. LEDs are more efficient in terms of energy conversion, according to Bula, but florescent lighting is significantly less costly to install. He added that plans are for the next generation of plant growth chambers to be equipped with LEDs as the lighting system.

The NASA tests proved that plants could grow in microgravity, with potato plants grown over a 10-14 day mission producing tubers.

Bula describes his most current project as the "evolution of years of controlled environment experiments." In 2004 he began to use his familiarity with sound scientific procedures to perfect and test his high-tech minituber production system.

Bula's methodology involves validating three specific hypotheses. The first variable was the chamber itself. He began with one chamber, which was fabricated in Poland, and fine-tuned its design, function and efficiency.

"The chamber must be highly reliable and efficient," says Bula. Electricity costs to run the nine chambers at the experimental site are around $1.50 per chamber, per day. Dependence on electrical power can be a problem, but Bula

has found plants can survive 24-48 hours of power loss without material damage.

Another chamber design issue is whether or not the unit is effective. "It is possible to be efficient and not effective," says Bula. "The ultimate question here was whether or not tubers could be produced in these chambers." Both suppositions have been validated.

The second premise to prove was the absence of pathogens. So far, all material produced in the Wisconsin lab has tested pathogen-free.

The third test is the field test.

"We're a year away from full field validation," explains Bula, adding that this fall's crop will provide much of the needed data.

Once the chamber design and growth methods have been validated, Bula and his associates will be ready to translate the experiment into a marketable product.

PRACTICAL APPLICATIONS

For potato growers like Bula's nephew Shawn Bula of Bula-Gieringer Farms, that means access to a reliable supply of low-pathogen seedstock and the chance to reduce crop loss from disease.

"It's all about production," says Shawn. "The market drove the development of certified seed and the market will drive the development of pathogen-free seed. It's a simple equation–if you don't produce, you're out of business."

For producers who might be leery of new technology, the CETS Tech method will hit the market with an available support system that includes guidelines for housing and equipment and hands-on training in addition to a license for use of the controlled environment software and technology.

The space-age technology also has implications for worldwide food production. Access to certified potato seed is absent or minimal in many developing countries, including some that rely heavily on potatoes as a food source. Poland, for example, uses only 5 percent certified seed. This technology could revolutionize production by increasing yields and quality and could add the ability to produce seedstock year-round despite climatic limitations. The technology also has implications for other areas of agriculture and agri-science, including the production of medical vaccines.

Bula is quick to emphasize that the minituber is not a new concept, nor is hydroponics. Plants have been grown in nutrient solution for nearly 50 years and Dr. Robert Hogus considered growing minitubers nearly 20 years ago. Entities that have been able to produce minitubers in a significant quantity have done so under only semi-controlled conditions, unlike the pathogen-free environment of Bula's experiments.

That may be about to change. With the experimental phase almost complete and CETS Tech ready to break into the market, pathogen-free minitubers may soon become the norm, raising the bar for potato producers worldwide.

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