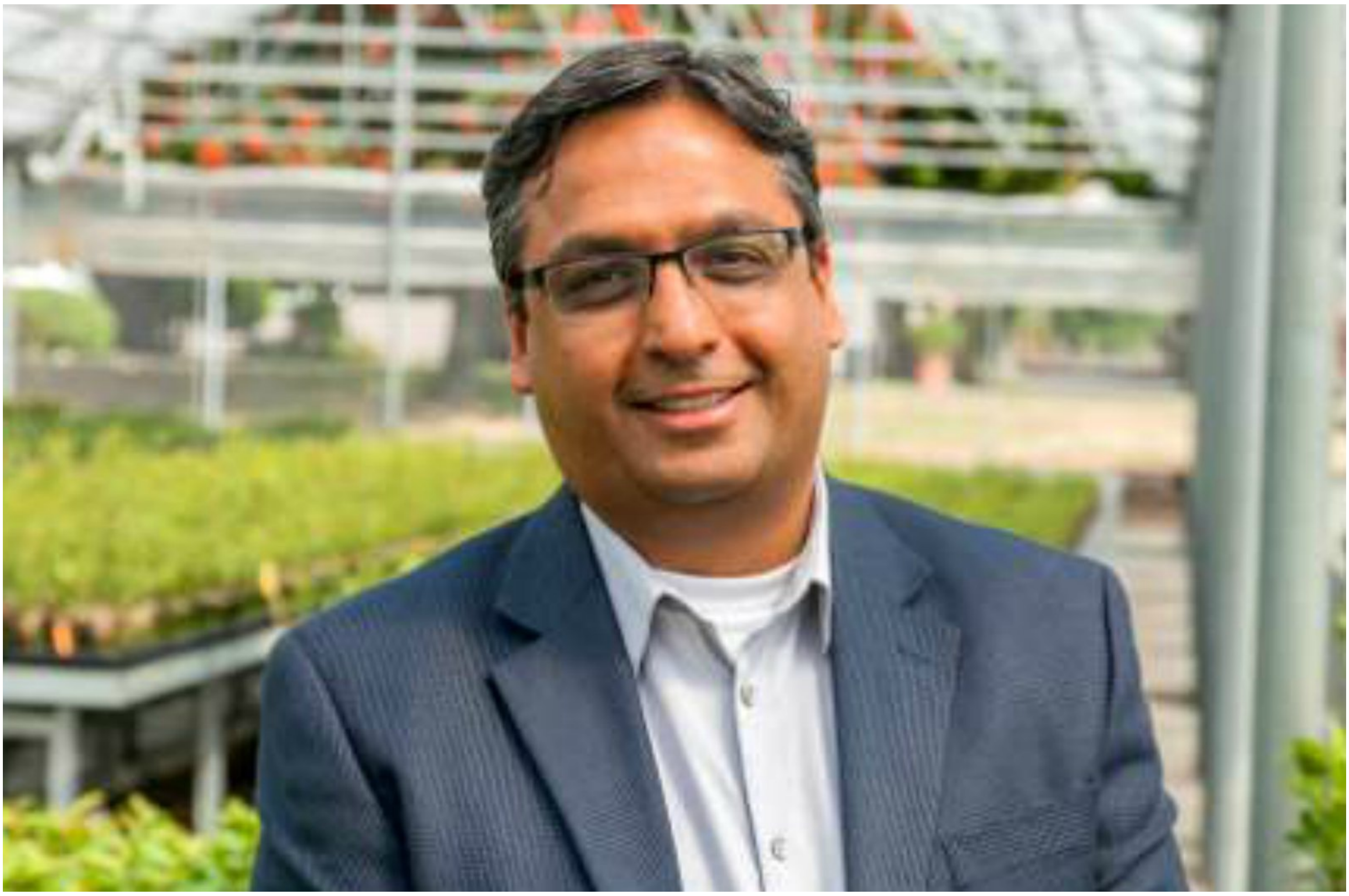
Better Plantlets For Better Plants

Washington State University
Washington State University Office of Commercialization



Using a proprietary growing method developed at Washington State University (WSU), start-up company Phytelligence is producing plants and trees faster than ever, offering a fresh alternative to tree farmers in an industry overripe for innovation.

> *We can produce in one year what is typically produced in three years: a 10-foot tall tree.*
>
> Amit Dhingra, Associate Professor of Horticultural Genomics and Biotechnology at WSU

The company's soil-less multiplication system — which requires less water and no pesticides — combined with genetic analysis services to ensure the identity of tree species offers tree farmers a way to improve profitability and reduce their environmental impact.

"The company's plant multiplication method can produce 250,000 plants in one year from a single plant in five-week intervals," says Preeti Malik-Kale, Ph.D., Technology Licensing Associate in WSU's Office of Commercialization. "DNA testing prior to shipment guarantees the authenticity of the fruit tree or plant species being supplied to growers."

Tree Growing 101

Most trees are not grown from seed, but rather grafted on rootstocks — the root system and about 18" of tree stem — that are traditionally propagated in the ground at specialty nurseries. Once the rootstock is large enough, a branch from another tree representing a commercial plant variety (called a scion) selected for its fruit or another attribute is then inserted — or grafted — into the woody stem of the rootstock. After one or two years of growing time, the tree is uprooted and shipped to an orchard, where it takes an additional two to three years before the tree bears fruit.

"Nurseries are confined by the amount of land they have to grow with; 100 acres is a lot. It's a limiting factor and [space for new trees] only opens up every two to three years," says Dhingra.

Dhingra says traditional tree propagation is lengthy and rife with inefficiency: About 10 to 40 percent of rootstocks may eventually die, and 10 to 20 percent are not even the variety ordered — a nasty surprise that may come to light years after planting forcing the farmer to rip out trees from random spots in an orchard.

"This results in millions of dollars of loss to the industry," Dhingra told attendees at a TEDxWSU event in 2014. "It's a commonly accepted norm."

Indian-Born Botanist

Dhingra had an affinity for plants at an early age, but growing up in India furthered his resolve to work in agriculture and plant sciences.

"There were food shortages in the early '80s in India and seeing people dying from famine made a big impression on me," he says.

He earned bachelor's and master's degrees in botany in India followed by a doctorate in plant molecular biology from University of Delhi, India, and Rutgers University, New Jersey in 2000. Before joining WSU, he worked as a researcher at Rutgers, the University of Central Florida and University of Florida.

"From 1994 to 2015 my work has been in the broad area of photosynthesis, trying to change how plants grow and to produce them faster," he says.

When Dhingra joined WSU in 2006, there was little gene-based information on apples, pears and cherries, so he mapped the genome of each in collaboration with colleagues from Chile and Europe.

"I was like a kid in a candy store; the field was wide open," he says.

Meeting Farmers

Dhingra also traversed the states of Washington, Oregon and California — top producers of apples, cherries, raspberries and grapes — which gave him a better understanding of the problems faced by nurseries, farmers and fruit packagers.

"There were common themes everywhere," he says. "Farmers would tell me they were waiting for a million plants and they'd maybe get 10,000."

Neither traditional propagation nor a newer alternative called plant tissue culture or micropropagation were able to meet the demand for rootstocks. In micropropagation, cultivation occurs not in soil but in the laboratory, where a small amount of tree tissue (called an explant) is added to a sterile container filled with a gel-based mixture of nutrients and placed under artificial light.

“Apple trees multiply in soil slowly, and tissue culture wasn’t efficient because they were using a one-size-fits-all approach,” he says. “A lot of tissue culture labs were using compounds formulated for tobacco. I knew that wouldn’t work, so I began developing my own formulations.”

Growing Formulations

Dhingra and students in his horticultural genomics laboratory went to work experimenting with different compounds in agar-based media in which explants of various plant species would quickly multiply.

“I was fortunate to have students who were open to a city kid from New Delhi who told them to come along with him and meet with farmers and who wanted to have a practical impact beyond learning,” he says.

Tyson Koepke was just beginning his doctoral work in Dhingra’s lab in 2007 when he was asked to work on a growing medium for sweet cherries alongside other graduate and doctoral students assigned to different plants. Five-and-a-half years later, the group had perfected four media packages and growing processes for apple, pear, cherry and grape species, each of which included specially customized compounds for four growth stages.

During each five-week growing period, explants multiply three- to five-fold and are divided and placed into containers with a new mix of customized nutrients. After several months in a carefully controlled laboratory environment, the plants are moved to a greenhouse where they continue growing for approximately 4-6 months.

“There are other tissue culture labs out there, but [our] group figured out how to make cultures more viable and developed protocols for growing higher quality plants,” says Koepke.

Going Commercial

When a pair of undergraduate students suggested that Dhingra explore commercializing the multiplication method, he met with representatives of WSU’s Office of Commercialization to discuss the intellectual property management and commercialization plan. Because the growing compounds developed in Dhingra’s lab were essentially recipes, the Office decided to classify the intellectual property as trade secrets.

In 2012, Dhingra, four students and a laboratory manager founded Phytelligence — the first plant-focused biotechnology startup to come out of the university — and licensed the media packages and protocols as well as the software for verifying plant identity through high-resolution genetic analysis.

“When we started the company, it wasn’t just me, it was a group of co-founders,” says Dhingra, who now serves as CEO of Phytelligence. “It changed the paradigm on campus because this was the first group of graduate students to start a company in plant science. It has become motivation for other Ph.D. students to form companies.”

WSU’s Office of Commercialization also connected Dhingra with experts who could help draft a business plan as well as potential investors — 70 percent of the company’s $1 million in start-up funding came from Washington growers and nurseries.

From Researcher to Entrepreneur

Two weeks after Koepke completed his doctorate, he became the director of operations at Phytelligence and began outfitting the lab and building the company’s team, which has grown from three full-time employees in early 2014 to 24 employees today.

After shipping 110,000 plants last year, the company is on track to deliver up to 300,000 plants in 2015. In addition to performing genetic testing on each plant it produces to ensure the rootstocks are true to type, Phytelligence also offers genetic analysis services to farmers and nurseries.

“Because of our genome sequencing and analysis expertise, we know how to assure each plant is true to type so it doesn’t have to be dug out of the ground and present a problem to a farmer a few years later,” says Dhingra.

Koepke says the company has also been able to achieve propagation rates that are in some cases two to five times faster than those of competing tissue culture labs.

“We’re able to improve the business cycle for the average apple farmer,” says Dhingra. “They get trees to plant one to two years after ordering, 95 percent survive and all rootstocks are as ordered, resulting in 20 percent extra income annually for the farmer.”

In addition to benefitting tree farmers, the Phytelligence multiplication system has significant environmental benefits: The process requires no insecticides, pesticides or fungicides and, compared to traditional propagation, uses 50 to 80 gallons less water per tree produced.

Fruits to Nuts to Forests

Phytelligence is now exploring ways to expand, including franchising or establishing partnerships with other tissue culture labs. Long-term, the company hopes to apply its soil-free multiplication technology to citrus trees, nuts and forestry. In addition to introducing a new media package for raspberry plants, the company continues to research growing compounds for other plant species.

“There’s an art and science to developing superior formulations, and we have to work all the time at improving, and now we have the engine doing that,” says Dhingra. “We’ve just started scraping the surface of how to improve growing trees. The secret is to keep on innovating and leading the field with cutting-edge research.”

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