

Cannabis

Markets opening up, will agronomy follow?

The commercial cannabis industry has exploded in recent years, especially in North America and in Canada in particular. Indeed, Canada has become “ground zero” for the cannabis business, with Canadian companies such as Canopy Growth Corporation and Aurora Cannabis Inc. drawing headlines for sky-high valuations, high-profile acquisitions and international expansion plans. Much of the crop’s meteoric growth, in Canada at least, can be attributed to that country’s legalization of the production and sale of recreational marijuana to adults in 2018. But, of course, these companies also produce cannabis for the medical marijuana industry, which continues to gain footholds around the world. Ever more countries are approving regulations to allow the medical cannabis industry to make inroads into new markets. Europe’s medical cannabis industry alone is estimated to be worth almost \$70 billion by 2028, according to the most recent European Cannabis Report (published by Prohibition Partners) and has already attracted significant investment from North American firms. This number is eclipsed by any future legal recreational market, representing an estimated value of \$155 billion by 2028. [REDACTED] writes about the potential for bio-input companies to take advantage of this growing market.

THE CANNABIS INDUSTRY CONTINUES TO MAKE HEADLINES AROUND THE WORLD.

While it seems everyone is jumping on the bandwagon to grow the stuff, be it for medicinal uses or for the growing number of countries that allow recreational usage, much still needs to be researched about growing cannabis for its various markets. There are three options to grow cannabis: outdoor, indoor and

greenhouses. For the most part, cannabis for the medical and licenced recreational marijuana sector is grown in massive greenhouses and indoor production sites. Indoor cultivators produce year-round and can generate between four and six harvests per year. Greenhouse cultivators, meanwhile, combine elements of exploiting natural light while leveraging infrastructure and technology. They can produce one to four





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harvests per year, though sophisticated, well-equipped greenhouses can run year-round on schedules comparable to indoor production. Cannabis belongs to the genus



Cannabis in the family Cannabaceae and may include three species: *C. sativa*, *C. indica* and *C. ruderalis* or one variable species. It is typically a dioecious (each individual is either male or female) annual plant.

C. sativa and *C. indica* generally grow tall, with some varieties reaching four metres. Female plants produce tetrahydrocannabinol (THC, the principal psychoactive constituent of cannabis), up to 29 percent by weight, as the season changes from summer to autumn. *C. ruderalis* is very short, produces only trace amounts of THC, but is very rich in cannabidiol (CBD), which may be 40 percent of the cannabinoids in a plant and is an antagonist to THC, and it flowers independently of the photoperiod and according to age. However, commercial cross-bred hybrids containing both ruderalis, indica and/or sativa genes exist (usually called autoflowering).

Outdoor production of hemp or cannabis is about 22-26 weeks.

However, growing indoors or in a greenhouse is much quicker with 12-15 weeks being normal from clone to finished flower.

Due to the high value of cannabis, ensuring disease and pest control is crucial, and maintaining complete environmental control allows companies to materially influence the variables that lead to consistent production, optimal yields and greatly reduce the risk of crop losses.

According to Jan Slaski, PhD, principal researcher with the plant sciences division of Innotech Alberta in Vegreville, Alberta, Canada, it's better to prevent than to cure and that is a key factor.

"If you go to a leading marijuana or cannabis facility today, you have to shower, change clothes, wear only their gowns and hair

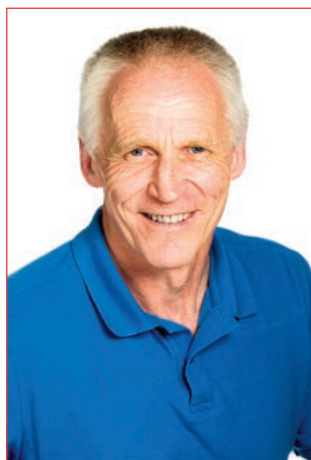
nets, and the air is filtered to prevent contamination," he said. "This is extremely important. Serious companies pay attention and put a lot of money up front to minimize potential of any fungal or bacterial or insect contamination or infection."

Indeed, cannabis, like any crop, can have disease and pest issues, and that is creating a wide-open market for the biocontrol industry to make inroads. Because cannabis is subject to very strict regulations on pesticide use, pest management can be challenging, and crop damage and losses are a risk. It's expected biological beneficials can help forge the way for medicinal-grade cannabis crops which are highly regulated in regard to which products can be used during production.

Slaski said one of the biggest threats to commercial cannabis production is powdery mildew. "And many companies claim they have solutions to control powdery mildew," he noted. "But growers must be very careful to not buy 'snake oil.' Cannabis growers have deep pockets and the industry is like a gold rush – everybody wants to sell their products into it."

Slaski said there is a lot of publicly-funded research into crop agronomy. But in cannabis crops, the same isn't true. "Cannabis/marijuana is a new crop, and potentially a crop with higher profit margins," he noted. "But a lot of agronomic information on best growing methods is not publicly available."

One of the tactics most in the industry agree with is that applying biocontrol preventatively works better than curatively.



Michael Brownbridge, research director horticultural production systems at Vineland Research and Innovation Centre, said while there are very good biocontrol agents on the market, it's best to proceed with caution when using products in cannabis crops.

That's important when you're dealing with the various pests and diseases that can rob cannabis crops of their potential.

According to Michael Brownbridge, PhD, research director horticultural production systems at Vineland Research and Innova-

Matthew Brecht, PhD Key Account Manager, Marrone Bio Innovations



What are the main pest problems in cannabis, and how can they be solved with biocontrol measures?

Growing cannabis outdoors has basically the same inputs and growing timings and issues as CBD hemp. Biocontrol options have come a long way in both efficacy and cost. All insect and disease issues in cannabis can be prevented and even cured with biocontrol products, though they often need several repeated applications and are slower to work than traditional pesticides. Spraying biocontrols preventatively work better than curatively and most indoor cannabis grow operations are on a good preventative biocontrol program and free of pests. Diseases include Fusarium, Pythium, powdery mildew and Botrytis bud rot. The major insects are root aphids, russet mites, spider mites, and thrips. There are other pests, but those are generally the worst ones. Currently the products allowed on cannabis in the U.S. are usually OMRI (Organic Materials Review Institute) certi-

fied and many are 25b exempt from EPA registration.

What research is Marrone undertaking with regard to biological control of pests in cannabis production?

Marrone Bio is currently working with Simon Fraser University in B.C., Canada, Oregon State University, and The Collins Ag Group in Oregon, USA. We are doing research on most of the cannabis diseases and insects listed earlier with our biopesticides: Regalia CG, Venerate CG, Grandevo CG and Stargus.

In greenhouse production, prevention is key. Does that trickle through to cannabis production as well? Better to prevent before a problem arises than to try and solve the problem?

Absolutely. Those that do a routine preventative spray program have little to no issues with pests and can increase their yields and quality of flower.

What can these large commercial growers due to mitigate disease and pest problems in large cannabis growing facilities?

Stay on a consistent preventative integrated pest management (IPM) program and maintain good sanitary practices and protocols. Growers should always feel free to reach out to their pesticide sales representatives or local plant disease clinic for expertise. They can provide valuable technical information on how to treat your pest issue effectively.

tion Centre in Vineland Station, Ontario, Canada, prevention of crop pests is key when it comes to cannabis production. Indeed, to potentially reduce the pest pressures, biosecurity and having very high levels of cleanliness around those early stages of production are critical.

"As I've seen, the pests are coming in from somewhere, they're getting onto the plants from somewhere. And really the earlier you start your pest control measures biologically, the likelihood that they're going to be successful increases," said Brownbridge. "Not only that, it's starting a crop clean; so having a propagation area where you know there's very strict restrictions around use of plant material, people who can access that space, basically not allowing pests to come into that room."

Two of the biggest pests in cannabis production systems are aphids, including the root aphid, a problem to plants grown in pots, and the cannabis aphid.

"Not a lot is known about (cannabis aphid) right now," said Brownbridge. "We do know that a lot of the current suite of aphid parasitoids just don't like to parasitize it. And whether that's a mismatch between parasitoids and aphid or it's the plant itself because of the phenols and terpenes, it might not be particularly

attractive to some of these parasitoids."

Other pests include ones found on most greenhouse crops, including two-spotted spider mites, broad mites and thrips. And, of course, "powdery mildew is probably the number one disease they're having to deal with."

Brownbridge said there are biocontrol options out there, but it's a case of buyer beware for cannabis companies.

"There are very few what I would call really efficient biocontrol agents, particularly for the aphid pests," he noted. "They might work for the spider mites, but again, it's a little like trying to put a round peg into a square hole sometimes. To just use the same suite of biologicals that work well in a vegetable crop or in a floriculture crop and say, well, that'll work well in cannabis. You know it doesn't always just transfer over that simply."

Brownbridge said there is huge room for improvement in biocontrol, by bringing or identifying new biocontrol agents specifically for use in cannabis or adapting the way growers use biocontrol agents in cannabis.

Until then, he noted there are some very good biocontrol agents on the market and it's a matter of recognizing who the reputable companies are.

"These probably aren't the same



Jean-François (JF) Bonal General Manager, Biobest Canada/USA



"Medical, legal cannabis is something that is extremely regulated and as a consequence, permits for using chemicals are very limited. A lot of work has to be done on the prevention of pests and disease.

Initially, we are a pollination company. We started in the 1990s when pollination in greenhouses was becoming an issue; greenhouses were expanding but there was a lack of pollinators in the greenhouses. That's how we came out with the notion of implementing bumble bees in the greenhouses for pollination. Since then, our activity has grown towards biocontrol and providing sustainable solutions for sustainable agriculture. Today, a big chunk of our activities is providing good bugs that prevent bad bugs.

In cannabis, you will find similar pests as you will find in protected crops, and you will have varia-

tions depending on the region. You will find thrips, you will find your spider mites, russet mites, root aphids.

There is a considerable amount of development on cannabis and companies are managing, providing solutions based on what is known on other crops. But there are also developments that are made internally. And research that is done internally. This information is very proprietary.

Going back to our core crops, we have traditionally developed our activities in greenhouses: tomatoes, green peppers, cucumbers. We are also very active on ornamentals, we're very active on berries. As we see medicinal cannabis developing around the world, this is really a global trend. So we are also taking the same approach, which is to have sustainable advice. In this case, that means providing growers with advice and programs that match their needs. Where the relationship is a little bit different with medicinal cannabis is that there is no recourse, i.e. chemical treatment for correction.

The bulk of the work is on prevention, having programs and recommending programs that are preventative. Recommending the scouting, helping on the scouting, identifying early if there is any digression.

It's integrated pest management for all the cultural practices, and starting with a clean plant and a clean environment and remaining as clean as possible."

companies that many of the growers bought from before cannabis was legalized. But they're well-known companies that are already established and working in the field of horticulture," said Brownbridge. "Pick companies that already work with

greenhouse vegetable growers or floriculture producers. They've got reputation in terms of the quality and consistency of their products, and the knowledge of their technical agents and the support of that company behind the products." ■

RESEARCHING CANNABIS - A CANADIAN VIEWPOINT

For nearly two decades, Alberta Innovates' subsidiary InnoTech Alberta, has run a successful research and development program on cannabis at their Vegreville, Alberta, Canada location.

InnoTech Alberta's Crop Development and Management team works with both industrial hemp, which has less than 0.3 per cent tetrahydrocannabinol (THC—the psychoactive substance responsible for the high) and marijuana (also known as high-THC cannabis). The team has provided long-standing support for Canada's hemp industry, including testing of new varieties, hemp processing research and development of innovative products from hemp seed and fibre. On the marijuana front, InnoTech Alberta was the exclusive provider of bioanalytical testing for 13 years to Canada's first legal producer and distributor of medical cannabis.

Now, even more opportunities for R&D and service provision are opening up.

Building on InnoTech Alberta's history of testing medical marijuana, the Bioanalytical Laboratory in Vegreville is licenced by the federal government to test both industrial hemp and marijuana. The lab can test for moulds, mycotoxins (toxic compounds produced by moulds), bacterial contamination, pesticides and heavy metals.

"You have to grow marijuana in high humidity, which is conducive to mould development on the plants," explained Jan Slaski, PhD, principal researcher with the plant sciences division of InnoTech Alberta. "When the batch is dried, the moulds and mycotoxins might remain along with pesticides that are often used to control mould. These

could make a person sick or even be deadly. Growers have to prove the purity of their product."

Regulators are turning to InnoTech Alberta for molecular profiling of cannabis. This technology can accurately identify hundreds of strains of marijuana, a vital tool to help prevent an influx of illegally-grown marijuana into retail stores. Research is also underway on a technology to identify the place of origin of a cannabis sample based on its water isotope make-up.

InnoTech Alberta has also been approached by marijuana growers to use the controlled environment facility in Vegreville for experiments on crop management practices to increase yield and reduce disease. Currently, industrial hemp is being used as a proxy for marijuana in these experiments.

But Slaski admits companies that grow cannabis work for themselves and are not sharing any agronomic/growing information with others. "If they discover something that is advantageous, for instance some super-duper biocontrol agent, they are not willing to share that information. I observed that same pattern of behaviour 10 to 15 years ago with hemp. There's very little information in the public domain."

At InnoTech Alberta, Slaski said their research focuses on a three-pronged approach at the moment: sanitation, genetics and biocontrol strategy. "We have ordered some exotic genetics and are identifying genes to look at the infection mechanisms and resistances," he noted. "We're also looking at some means of controlling powdery mildew. But as I said before, this is all proprietary work, so the public cannot see it."

COUNTRIES THAT LEGALLY GROW MEDICINAL CANNABIS

On Oct. 17, 2018, Canada became only the second country in the world, after Uruguay, to formally legalize the cultivation, possession, acquisition and consumption of cannabis and its byproducts. But just because a country may allow citizens to utilize cannabis for, say, medical conditions, not all countries allow cultivation of the crop. Indeed, the cultivation and manufacturing sectors are somewhat limited, as many medical marijuana countries are still establishing their regulatory regimes and have awarded only a small number of licences for these types of businesses. The following list tries to be as comprehensive as possible, showing the countries in which individuals/licensed bodies may legally grow cannabis:

AUSTRALIA: Offers licences for commercial medical marijuana cultivation; medical marijuana research; and manufacturing, which includes extraction and product formulation.

CANADA: Licences are available for standard cultivation for larger growers; micro-cultivation for smaller growers; nursery for growers of starting materials; industrial hemp; standard processing for larger processors; micro-processing for smaller processors; and testing, research and export/ import.

CHILE: Cultivation licences are awarded by the government for a one-year period. The Agricultural and Livestock Service of Chile has the authority to grant cultivation permits for large-scale growers, but the country thus far has awarded few medical marijuana cultivation licences.

COLOMBIA: Legal to grow, process, import and export medical cannabis and cannabis derivatives if you possess a federal licence from the National Narcotics Council and/or the health ministry.

CROATIA: In April 2019, the Amendments to the Act on Combating Drugs Abuse entered into force which allows the cultivation and production of low THC cannabis for medicinal purposes in the country.

CYPRUS: In February 2019, the Mediterranean island nation legalized marijuana cultivation, exports and imports of medical cannabis. It has now formed a special coordinating committee that will evaluate applicants for licences before choosing three winners. This trio will be the only firms permitted to grow cannabis in Cyprus for the next 15 years.

CZECH REPUBLIC: The country allows cultivation of THC cannabis plants for medical uses on the basis of a licence granted by the State Institute for Drug Control, or for scientific and research purposes.

GERMANY: Cultivation licences are open to foreign companies if they can establish residency or find a local partner to work with.

GREECE: In 2018, Greece lifted a ban on growing and producing medical cannabis. Producers are required to obtain pre-authorization before they plant, and must also obtain and use cannabis seeds that meet certain criteria.

ISRAEL: Israel is considered a trailblazer in medical marijuana research and cultivation science, and it allows an unlimited number of licences to grow cannabis.

ITALY: The Italian Ministry of Defence has the only licence to grow medical cannabis domestically and controls the country's production.

JAMAICA: The country legalized cannabis for medicinal cultivation in 2015, and offers a choice of several business licence categories, although businesses that apply for a licence must establish their company's "substantial" ownership and control (more than 50 percent) by a person who has lived in the country for three consecutive years.

LESOTHO: In 2017, the Lesotho Ministry of Health licenced a South African firm to grow cannabis in Lesotho for medical and scientific purposes, the first

such authorized establishment in Africa. Since then, several companies have been licenced to produce medical marijuana.

NORTH MACEDONIA: The country allows for cultivation of medical cannabis. Prospective cultivators must enter a rigorous process to acquire a licence which involves having a registered entity in the country, then submit a request for a licence while adhering to certain conditions in order to cultivate.

MALTA: In April 2018, the country issued The Production of Cannabis for Medicinal and Research Purposes Act, allowing entities to cultivate, import, process and produce cannabis intended for medical and research purposes under a controlled and supervised environment – provided they comply with all necessary regulations.

NETHERLANDS: One company (Bedrocan) is currently the only company in the Netherlands legally allowed to cultivate cannabis for medical and pharmaceutical use. However, in June 2019, the Office of Medicinal Cannabis (BMC) was expected to start the European tendering process for a second licence.

NEW ZEALAND: Currently, licences for cannabis can only be issued under the Misuse of Drugs Act to cultivate or extract cannabis for medical or scientific research, including clinical trials. The New Zealand government is currently looking at extending the current licensing regime to cover cultivation and manufacture of medicinal cannabis in the country for commercial purposes.

PERU: Earlier this year, the Peruvian government announced a licence-based system and regulations for legal medicinal cultivation and use. A production licence allows acquisition of seeds and/or seedlings of cannabis, planting, propagation, cultivation, harvest and post-harvest, and manufacture of products derived from cannabis, and storage and transport activities regarding cannabis for medical use.

PORTUGAL: Portugal issues licences to companies for cultivation, extraction and manufacturing for medical cannabis cultivation.

TURKEY: The cultivation of marijuana is legal in 19 provinces in Turkey for medicinal and scientific purposes. However, with permission this can also be conducted in other provinces as well.

UNITED KINGDOM: The British government allows cannabis to be grown on an industrial scale, and the UK is the world's largest exporter of cannabis for medicinal and scientific purposes, according to a 2018 report from the UN's International Narcotics Control Board. Because of strict regulation, it is difficult to obtain a licence to grow, market and distribute medical marijuana in the UK.

UNITED STATES: Cannabis remains illegal at the federal level, but 33 states, four US territories and the District of Columbia allow the use of medical cannabis. As a result, several states currently operate large medical cannabis growing facilities.

URUGUAY: In 2013, the South American country became the first nation to legalize recreational marijuana. Growing marijuana for medicinal use was also legalized under the 2013 law.