Hemp 'goes hot' due to genetics, not growing conditions

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Horticulture professor Larry Smart examines industrial hemp plants growing in a greenhouse at Cornell AgriTech in Geneva, New York. Credit: Justin James Muir/Cornell University

As the hemp industry grows, producers face the risk of cultivating a crop

that can become unusable—and illegal—if it develops too much of the psychoactive chemical THC. Cornell University researchers have determined that a hemp plant's propensity to 'go hot' - become too high in THC—is determined by genetics, not as a stress response to growing conditions, contrary to popular belief.

"[People thought] there was something about how the farmer grew the plant, something about the soil, the weather got too hot, his field was droughted, something went wrong with the growing conditions," said Larry Smart, horticulture professor and senior author of the study. "But our evidence from this paper is that fields go hot because of genetics, not because of environmental conditions."

Smart and his team conducted field trials at two sites, studying the genetics and chemistry of 217 hemp plants. They found that differences in growing conditions between the sites had no significant influence on which chemicals the plants produced. But when they compared the CBD (cannabidiol) and THC levels of each of the plants against their genomes, they found very high correlation between their genetics and the chemicals they produced.

Jacob Toth, first author of the paper and a doctoral student in Smart's lab, developed a molecular diagnostic to demonstrate that the hemp plants in the study fell into one of three genetic categories: plants with two THC-producing genes; plants with two CBD-producing genes; or plants with one gene each for CBD and THC.

To minimize the risk of plants going hot, hemp growers ideally want plants with two CBD-producing genes.

While conducting the research, the team also discovered that as many as two-thirds of the seeds they obtained of one hemp variety—which were all supposed to be low-THC hemp—produced THC above legal limits.

The researchers hope their work will help address this problem by providing breeders with easy-to-use genetic markers that can be utilized much earlier on seedlings and both sexes of plants. CBD and THC are produced by only females, but breeders may be using a male plant for cross pollination without knowing if it has genes for THC production, until it appears in their female offspring, Toth said.

The team also developed genetic markers to determine the sex of hemp plants prior to flowering, since the sexes of young plants are indistinguishable. "This technology is, at this point, too expensive for farmers to use on an entire field, but it will be very useful for breeders who want to separate males and females early on to better control cross-pollination," Smart said.

Smart said future research in his lab will focus on breeding hemp cultivars—for CBD, grain and fiber—that are high-yield, legally compliant and adapted to New York's growing conditions.

The study was published in *Global Change Biology-Bioenergy*.

More information: Jacob A. Toth et al, Development and validation of genetic markers for sex and cannabinoid chemotype in Cannabis sativa L., *GCB Bioenergy* (2020). DOI: 10.1111/gcbb.12667

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