

Hemp Nutrient Disorders Scientific Research Update from NC State:

"Characterization of Nutrient Disorders of Cannabis sativa" has been published with open access in Applied Sciences

We at NC State have been focusing our research and publishing efforts to help fill the plant nutrition science void in cannabis. Our research has already garnered a few publications. A summary of our most recent publication which is open access is the focus on the second half of this article. If you or your grow operation needs information on nutrient disorders, symptomology, or critical leaf tissue values for cannabis you may want to also utilize our resources published:

Nutrient Matters Series (a nutrient related article has been highlighted every issue for the past 9 months) in Cannabis Business Times.

Our articles focused on: Substrate pH, Electrical Conductivity, Nitrogen Management, Sulfur, Magnesium, PourThru Nutrient Monitoring, Balancing Nutrients, Alkalinity, and Tissue Analysis.

[\(https://www.cannabisbusinesstimes.com/article/balancing-the-nutrient-equation-cannabis-cultivation/\)](https://www.cannabisbusinesstimes.com/article/balancing-the-nutrient-equation-cannabis-cultivation/).

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²Hunter Landis and Kristin Hicks; North Carolina Department of Agriculture & Consumer Services



Funding Generations of Progress
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Figure. 1. The nutrient disorder system at NC State University. Photo: NC State Research.

Leaf Tissue Standards.

Expanding leaf tissue nutrient survey ranges for greenhouse cannabidiol-hemp. This scientific article highlights critical leaf tissue values for different high CBD cultivars (<https://dl.sciencesocieties.org/publications/cftm/abstracts/5/1/180081?access=0&view=article>)

The information above and our recent published nutrient disorder guide are important given the recent changes in legislation both at the federal and state levels, there has been increased interest in the growing, processing, selling, and using products containing cannabidiol (CBD) derived from hemp flowers. Hemp has historically been grown for fiber and seed and due to recent changes in legislation it is being grown for flowers. Hemp grown for flowers (floral hemp) follows a horticultural production model either in a greenhouse or bedded fields compared to fiber and seed hemp which follow an agronomic production model.

Plant tissue analysis has been used extensively for many decades to evaluate the nutritional status of a crop. Survey ranges for *Cannabis sativa* in greenhouse nursery production have been published by Bryson et al. (2014). Recently, a survey of five hemp cultivars in greenhouse production by Landis et al. (2019) as part of hemp partnership between NC State University (NCSU) and the North Carolina Department of Agriculture and Consumer Services (NCDA&CS)



Figure 2. Greenhouse view of the nutrient disorder system at NC State University. Photo: NC State Research.

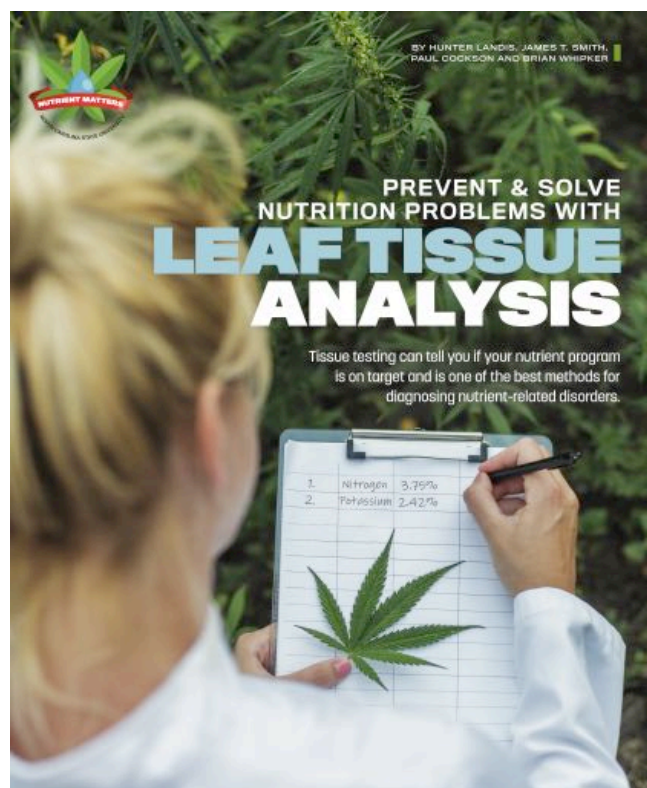


Figure 3. NC State University plant nutrition article series in Cannabis Business Times.

was published. These tissue values are useful for cannabis growers as they aid in fertility management.

Nutrient Disorders. Our NCSU and NCDA&CS partnership also conducted research investigating the crucial nutrient deficiency levels in the leaf tissue of cannabis. Once a plant begins showing visual symptoms of impaired growth, reduction in plant health or yield is implicit. In our study, when plants began showing deficiency symptoms for each nutrient, most recently mature leaf samples were analyzed for that nutrient. This is information can be used by growers and researchers to confirm visual diagnosis with leaf concentrations.

Additionally, visual guides of nutrient deficiencies in cannabis supported with leaf tissue analysis and documenting a progression of symptomology have not been published. Tracking the specific symptomologies of various nutritional disorders over time is important because symptomologies change in appearance and location as the deficiency progresses making correct diagnosis challenging. Therefore, our study was conducted to provide cannabis growers and researchers with descriptions of nutrient disorders, high quality images to track the progression of these disorders, and leaf tissue nutrient concentrations associated with documented deficiency symptomology.



Figure 4. Nitrogen deficiency occurring on rooted hemp cuttings. Photo: Brian Whipker

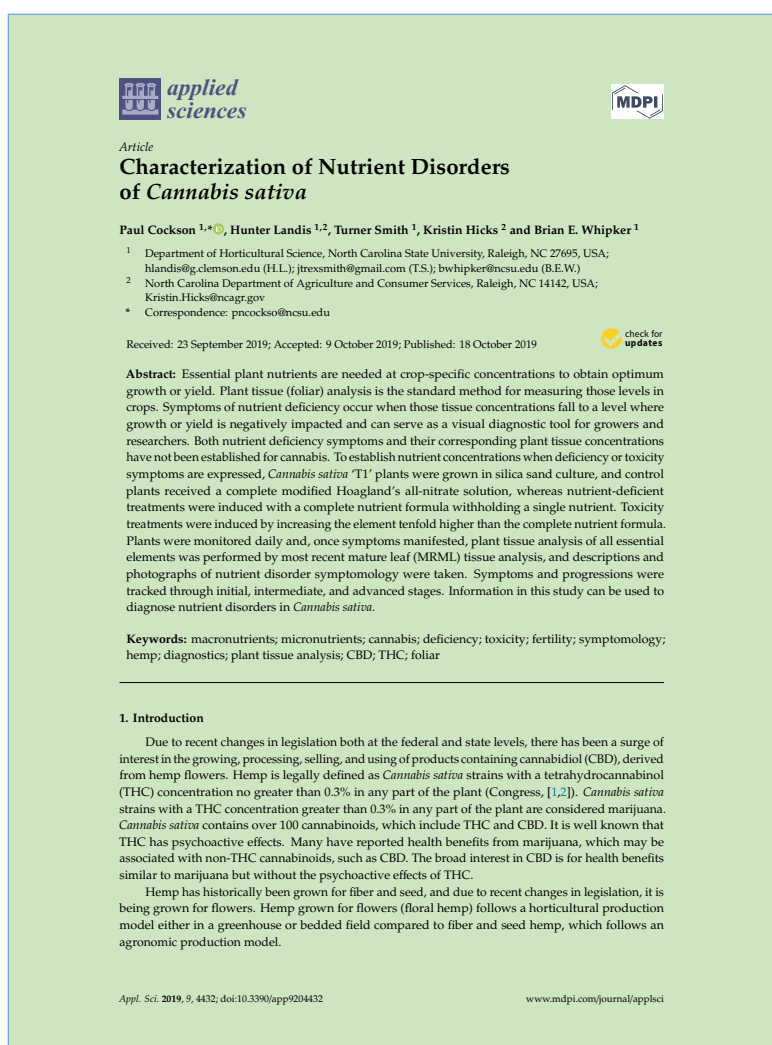


Figure 5. Hemp nutrient disorder scientific article in Applied Sciences.

Our goal was to present this information in a freely available fashion to cannabis growers and scientific researchers. In this end, we purchased open access of the research results. Thus, our work and the associated data and pectoral guide can be downloaded for free by those who are interested. The links to the scientific publication can be found at:

"Characterization of Nutrient Disorders of *Cannabis sativa*" by Paul Cockson, Hunter Landis, Turner Smith, Kristin Hicks, and Brian Whipker has been published in Applied Sciences and is available free online:

Abstract: <https://www.mdpi.com/2076-3417/9/20/4432>

HTML Version: <https://www.mdpi.com/2076-3417/9/20/4432/htm>

PDF Version: <https://www.mdpi.com/2076-3417/9/20/4432/pdf>

Future. With so many needs from industry, and so little information, the team at NC State is continuing our cannabis plant nutrition research. We currently have a number of research projects and collaborations. Stay tuned for more research, outputs, and publications!

Literature Cited

Bryson, G.M., Mills, H.A., Sasseville, D.N., Jones Jr, J.B. and Barker, A.V., 2014. Plant analysis handbook III: A guide to sampling, preparation, analysis and interpretation for agronomic and horticultural crops. *Inc. Athens, GA, USA.*

Landis, H., Hicks, K., Cockson, P., Henry, J.B., Smith, J.T. and Whipker, B.E., 2019. Expanding leaf tissue nutrient survey ranges for greenhouse cannabidiol-hemp. *Crop, Forage & Turfgrass Management*, 5(1).



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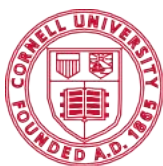
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