

Is COVID-19 impacting plant science, and is plant science impacting COVID-19?

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Abstract

COVID-19 changed 2020 massively after becoming a worldwide pandemic. Many countries affected by the disease witnessed disruptions in the agricultural, farming, industry, production and distribution sectors, causing a loss of crops due to reduced consumer demand. Sales of cut flowers, potted plants and seasonal crops that are sensitive to specific seasons or dates were affected, as were fertilizer and food security. Academics, including plant scientists, with limited work or research conditions during the pandemic, alleviated their work through alternative approaches, e.g., *in silico* research, or made more time to writing research papers, while student education has largely been placed on hold or held online by lecturers. Most COVID-19 research has focused primarily on medical and social aspects while some plant science-related research has been conducted on the use of traditional medicinal plants as possible alleviating agents, but not cures, to COVID-19 patients. The integrity of science and publishing, including research related to plants, is being tested as cases of superficial research, lax or superficial peer review, and misinformation abound. COVID-19 has thus had limited impact on plant science, and *vice versa*, thus far, even though it is likely that most plant scientists were affected.

Keywords: food security; herbal and medicinal plants; pandemic; plant-based medicine and vaccines; plant research; SARS-CoV-2; viruses

Introduction

In 2020, the world was radically transformed by the coronavirus disease (COVID-19) pandemic caused by the severe acute respiratory syndrome coronavirus type 2 (SARS-CoV-2) virus. Data from John Hopkins University states that, on July 16, 2020, COVID-19 had already infected 13,405,694 people and caused 580,552 mortalities around the world¹. Countries have responded differently, including partial or total lockdowns, restricted travel, or physical social distancing, halting an estimated 81% of the global workforce². In some countries, agriculture, farming, food, industrial, production and distribution sectors have come to a

¹ <https://coronavirus.jhu.edu/map.html> (last accessed: July 16, 2020).

² https://www.ilo.org/wcmsp5/groups/public/---dgreports/---dcomm/documents/briefingnote/wcms_740877.pdf (last accessed: July 16, 2020).

grinding halt, and commodity prices and profits have been slashed (Schmidhuber *et al.*, 2020)³ as the workforce was paused or faced employment termination due to companies' financial woes, causing food and labor shortages (Nature Plants Editorial, 2020). Industrial agriculture, in response to this vulnerability, led to a waste of resources (Altieri and Nicholls, 2020). A slump in the prices of sulfuric acid may affect fertilizer markets⁴. Considering that ~27% of the global working population works in agriculture⁵, COVID-19 will impact not only the agriculture sector, but society as a whole because supply chains are disrupted⁶. Food security may also be at risk⁷. Cut flowers, fresh produce and potted plants, many of which are seasonal, grown for specific dates and occasions, and which serve the ornamental, tourism, restaurant and many other axillary business sectors, were affected as fresh produce needed to be discarded due to spoilage and lack of demand⁸.

Education, including at universities, research institutions, and schools closed down (Viner *et al.*, 2020)⁹, and the internet became a virtual tool of communication and teaching, with online classes held for students, video-conference moderation by teachers at schools and lecturers or professors at universities, and online-based written assignments and exams (Almarzooq *et al.*, 2020). In the fields of education and research, COVID-19 is likely having a similar impact on plant scientists as on other academics around the world although there is no direct study that has specifically assessed the impact on plant scientists.

Without access to universities, research institutions, or agricultural testing fields in COVID-19 red zones, many researchers in plant science have restricted access to research material and data. Even if granted access to the workplace, stringent regulations may negatively impact the workload, working environment and working period, forcing some to spend their time at home writing papers to avoid psychosocial problems (Bouziri *et al.*, 2020). Some online resources and classes for education in plant science were provided by some institutions during the pandemic¹⁰. The use of bioinformatics databases and *in silico* approaches to research, such as *in silico* PCR, or modelling (e.g., molecular docking analysis), can be conducted remotely, allowing some productivity to continue.

Research has focused primarily on medical and social aspects of SARS-CoV-2 or COVID-19, but little on plant science, which has also been impacted, directly or indirectly. The most common is research on plant secondary metabolites or ethnomedicinal plants as possible treatments of COVID-19, e.g., Ul Qamar *et al.* (2020). Wu *et al.* (2020) provided a list of about a dozen traditional Chinese herbal and plant-based medicines that have alleviated the progression of COVID-19 while Vellingiri *et al.* (2020) postulated that Indian medicinal plants, which have shown promising antiviral properties against other viruses, may also show promise against COVID-19. However, using only molecular docking studies or reliance on antiviral properties reported against other coronaviruses (e.g., SARS-CoV or Middle East respiratory syndrome coronavirus), most of the studies listed by Wu *et al.* (2020) remain theoretical, and those by Vellingiri *et al.* (2020) are hypothetical, so their efficacy against COVID-19 remains speculative until clinical human trials can be completed.

Some good plant-based research may have practical value to global health. In the field of plant biotechnology, plants can be used for molecular farming, allowing plants to be engineered to produce antigens for vaccines or diagnostic reagents (Capell *et al.*, 2020), i.e., plant-based vaccines against COVID-19 (Rosales-Mendoza *et al.*, 2020). Some studies used *in silico* testing and molecular docking software to assess the efficiency of plant secondary metabolites and other chemical compounds against SARS-CoV-2 proteins (Mpiana *et al.*,

³ <https://www.bcg.com/ja-jp/publications/2020/agricultural-industry-to-bounce-back-post-covid-19.aspx> (last accessed: July 16, 2020).

⁴ <https://www.bcg.com/ja-jp/publications/2020/agricultural-industry-to-bounce-back-post-covid-19.aspx> (last accessed: July 16, 2020).

⁵ <https://thsmarket.com/research-analysis/report-covid19-effects-on-the-fertilizer-industry.html> (last accessed: July 16, 2020).

⁶ <http://www.oecd.org/coronavirus/policy-responses/food-supply-chains-and-covid-19-impacts-and-policy-lessons-71b57ae4/> (last accessed: July 16, 2020).

⁷ https://www.ilo.org/wcmsp5/groups/public/---ed_dialogue/---sector/documents/briefingnote/wcms_742023.pdf (last accessed: July 16, 2020).

⁸ <https://www.floraldaily.com/article/9202961/covid-19-updates-from-around-the-world/> (last accessed: July 16, 2020).

⁹ <https://en.unesco.org/covid19/educationresponse> (last accessed: July 16, 2020).

¹⁰ <https://sips.cals.cornell.edu/extension-outreach/covid-19-resources/>; <https://aec.ifas.ufl.edu/resources/ag-teachers/>; <https://community.plantae.org/article/5509561630179985405/online-plant-science-related-courses> (last accessed: July 16, 2020).

2020; Sampangi-Ramaiah *et al.*, 2020). Plant-derived metabolites may in the future serve as effective disruptors of different components of SARS-CoV-2. For example, alkaloids might be used as an intracellular viral replication inhibitor DNA intercalating agent, phenolics bind with the membrane protein and spike protein, and essential oils (terpenes) can disrupt the viral lipid membrane due to their lipophilic nature (Jahan and Onay, 2020; Wink, 2020). Plant metabolites need to be clinically tested to support the findings of *in silico* modeling. The claims of ethnobotanical remedies serving as a cure or prophylaxis of COVID-19 are controversial, at best, since herbal medicine has both benefits and adverse effects (Vandebroek *et al.*, 2020).

The integrity of the plant science literature is being put to the test by COVID-19. Excessive volumes, peer reviewer and editorial overload, resulting in editorial oversight (Chirico *et al.*, 2020), and publishing too quickly invite the publication of erroneous research and the risk of bad science and predatory behavior (Teixeira da Silva, 2020) becoming part of the misinformation flow (Bell and Green 2020), issues that only post-publication peer review will be able to remedy over time.

Conclusions

Apart from direct impacts of COVID-19 on applied plant (agricultural crop) production, there is little evidence to suggest that plant science has been affected in any way as a field of study. The lives of plant scientist, as of other members of the public, has been disrupted, differently depending on the country, but there may be similarities in the lifestyle, social, psychological, educational and professional challenges that we have faced (Sofa and Sofa, 2020).

Authors' Contributions

Both authors wrote, read and approved the final manuscript.

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Conflict of Interests

The authors declare that there are no conflicts of interest related to this article.

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