Collaboration for Environmental Evidence

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Systematic Map
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Research of crop yields under low-inputs should be reprioritised to ensure the assessment of integrated interventions

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Photo:Dimitrios Savvas

Using tomato as an example crop, this work reviewed approaches tested in-field to improve or maintain yield under conditions where water-, nitrogen- and/or phosphorus-use was reduced. Such reductions are a demand of future-agriculture, which must become more environmentally sensitive. The review demonstrated that there is a lack of studies assessing tomato crop yield responses to integrated interventions and various key-resource deficits at the same time. This highlighted the need to reprioritise research and development efforts globally to ensure multiple interventions and resource deficits are assessed simultaneously to optimise resource use and crop production, whilst minimising environmental burdens.

Why is this Evidence Synthesis Needed?

Agriculture faces an unprecedented challenge to reduce its environmental impact whilst increasing yields for a growing global population. Tomato is very important in food cultures globally, and with major commercial significance. Tomato also serves as a critical model species for academic studies, the findings from which can be applied to improve many other crops too. Interventions which have been investigated to help maintain or improve field-grown tomato yields under reduced availability and/or application of key resources (water, nitrogen and/or phosphorous) include crop and soil management (e.g., cover crops and mulching), soil amendments (e.g., compost and manure), irrigation, fertilisation, bioactive molecules (e.g., plant hormones) and plant growth promoting microorganisms (e.g., specific strains of bacteria or fungi), natural fertilisers (e.g., forage legumes including clovers), breeding and genetics, techno-chemicals (e.g., controlled- or slow-release fertilisers), and computational interventions (e.g., precision agriculture, automated-systems for monitoring and remedial responses). This review identified and characterised the use of interventions which aimed to address the more efficient use of key-resources that facilitate high crop yields, and whose over- and mis-use is also environmentally damaging. It highlighted that there is a lack of research which simultaneously assesses the use of integrated interventions to combat reduced-availability or -application of multiple key-resources.

This Collaboration for Environmental Evidence systematic map examines the body of evidence that exists describing interventions which aim to improve or maintain the yield of field-grown tomato under reduced inputs of water, nitrogen and/or phosphorus by summarising evidence from 291 articles, describing a total of 461 interventions.

Main Findings

What studies are included?

This map identified 461 interventions spanning 8 intervention-groups, and these encompassed a wide variety of interventions whose occurrence from most to least applied included: (i) irrigation tools, (ii) fertilisation regimes, (iii) crop and soil management interventions especially cover crops, (iv) soil amendments including composts, (v) use of specific plant bioactives and crop growth-promoting or -protecting microbes and (vi) novel techno-chemical such as controlled- or slow-release fertilisers, (vii) breeding and genetic interventions including genetic modification interventions plus (viii) computational or artificial intelligence informed tools, or precision agriculture. Research interest in greater resource use efficiency with cropped systems has increased over the period assessed (1974 to 2019) and coincides with increasing awareness of the negative consequences which result from over-use of such precious and reactive resources. Additionally, most data is reported from only eight countries: the United States, India, Italy, Egypt, China, Nigeria, Turkey, and Saudi Arabia. Also, the evidence-base emerged from mainly short single-season studies.

What evidence exists on the relative diversity of interventions which are used to improve or maintain the productivity of field-grown tomatoes under reduced applications of water-, nitrogen- and/or phosphorus?

The findings highlighted that interventions may be 'stacked' or implemented collectively to improve resource use without compromising yield. However, several knowledge- and approach-gaps exist in the current evidence base, including concentrated effort on single resources (mainly water), and the lack of integrated interventions to assess multiple interventions and resources simultaneously. Additionally, this investigation highlights that there is a lack of evidence reporting the use of novel strategies such as techno-chemical interventions and breeding for greater resource use efficiency. There is also evidence that different countries or biogeographical regions focus on different interventions.

What are the Implications of the Review Findings?

This systematic map can be used by policymakers, who want to direct research and innovation, and/or best applied-agronomic practices. Given the significant knowledge gaps and lack of integrated practice identified here, and for a crop that receives a large amount of attention both commercially and academically, it should be anticipated that the same void exists to a greater extent for other less commercially important and academically scrutinised crops, such as maize, rice, wheat, soybean, and potato. The insight also highlights that strategic research effort and more-stringent governance measures could be implemented to ensure crop resource use-efficiency in practice - to help reduce the overall impact of agriculture on the environment without compromising yield. To confirm the extent of this potential a meta-analysis should also be conducted from one (or several) systematic reviews of the data presented.

Additionally, future research should focus on: 1) studies which investigate multiple resource deficits at the same time; 2) ensuring that a greater diversity of interventions are used simultaneously in any given biogeographical region; and 3) studies conducted over longer periods and in whole crop-rotation contexts.

Photo: Dimitrios Savvas

Synthesis Time Frame

The review authors conducted their searches between April and October 2019, with no time restriction applied. This CEE Systematic Map was published in June 2021.

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