EDITORIAL

Organic phosphorus: potential solutions for phosphorus security

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This special issue of *Plant and Soil* presents a collection of papers generated from the Organic Phosphorus Workshop that occurred in the Lake District of England in September 2016, with ~ 100 delegates in attendance (<https://op2016.com/>). This was the third in a series of such meetings, previously held in 2003 (Ascona, Switzerland; Turner et al. 2005) and more recently in 2013 (Panama City, Republic of Panama; Turner et al. 2015). Our aim was to assemble a contemporary snapshot of offered research papers in the subject area that also included some new reviews, reflections and commentaries that tried to challenge the subject and its progression. Accordingly, this editorial provides a brief opportunity to reflect on the range and scope of papers received and to put the subject into wider context; we will not provide an exhaustive discussion of all papers, instead wish to provide some context, as well as highlight some examples for our readers.

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The essence of the organic phosphorus and the food security challenge is summarised in the introductory Marschner review provided by Menezes-Blackburn et al., providing a reflection on the state of the art as of 2017. The paper asks:

“Recent scientific efforts have been directed toward increasing the plant availability of this legacy soil P and enabling an efficient agronomic use of this important P reserves. But, how likely is legacy soil P to be a key source of P to sustain agricultural production? For how many growing seasons would legacy soil P be able to sustain crop production, and what yields may be expected? What are our most promising and sustainable agroecological innovations to accomplish this?”

Menezes-Blackburn et al. provide an interesting meta-analysis that uses a collation of the phosphorus stocks analysed from global literature of ^{31}P -NMR data for agricultural soils, which eloquently reminds us that organic (diester and monoester) phosphorus forms typically represent around 30–40% of total soil phosphorus. They strongly argue that organic phosphorus may represent a potentially utilizable reserve of phosphorus, accessible through innovation in the areas of biofertilizers, engineered plants and agricultural management practices. In many respects, this sets the context for the other types of papers that follow in the special issue.

We received 21 offered papers with 13 making it through peer review. The accepted manuscripts cover

an appropriate range of topics related to organic phosphorus. This issue contains papers that we can class as ‘reviews’ (two papers, George et al. 2017 and Menezes-Blackburn et al. 2017), ‘plant centric’ (Li et al. 2017 and Darch et al. 2017), ‘soil centric’ (three papers, Stahr et al. 2017; Missong et al. 2017 and Spain et al. 2018) ‘microbial centric’ (two papers Nassal et al. 2017 and Gaiero et al. 2017), ‘analytical’ (two papers, Adams et al. 2017 and Whitfield et al. 2017) and ‘systems’ (two papers – Boitt et al. 2017 and Neal et al. 2017). An additional historical overview paper has also been published from the Workshop (Haygarth et al. 2018). We encourage readers to absorb in detail the material provided and also make their own opinions from these papers.

We would like to highlight an innovative approach led by Tim George with the Workshop Committee, as it tried to collect data from the ‘workshop’ itself, involving the delegates as co-authors. This was evidently a great challenge as it represents the elicitation of ~100 experts that were corralled throughout the workshop from the George and the Workshop Committee. To successfully engage so many researchers is potentially of great value to help progression of the subject and their collective viewpoint identified seven key opportunities for organic phosphorus research including:

- the need for integrated, quality controlled and functionally based methodologies;
- assessment of stoichiometry relationships of phosphorus with other elements in organic matter;
- understanding the dynamics of organic phosphorus in natural and managed systems;
- assessing the role of microorganisms in controlling organic phosphorus cycles;
- consideration of the implications of nanoparticles in the environment;
- the need for better modelling and understanding in systems context;
- improved outreach and communication of the organic phosphorus issues.

Each priority is discussed and a statement of intent for the organic phosphorus research community is made that highlights where there are key contributions to be made. Their table 1 provides a synthesis of the ~100 expert opinions on the global issues associated with organic phosphorus, and how the research community can potentially contribute solutions to

these issues, and identification of opportunities for research to facilitate this. We would particularly like to highlight one of the final statements made by George et al. that suggests:

“organic phosphorus research has a critical role to play in tackling a number of important global challenges and there are key contributions to be made toward understanding biogeochemical cycles, dynamics and function of natural ecosystems and the management of agricultural systems...”

and further that:

“the key to fostering this change will depend on logically communicating the importance of organic phosphorus to society at large, engaging with stakeholders on important global issues, and ultimately pushing this important area of research up the agenda of policy makers and funding bodies on a global scale.”

We hope that this collection of papers can help contribute to this.

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