## ifs

## International Fertiliser Society

## CHANGING CONCEPTS FOR THE EFFICIENT USE OF PHOSPHORUS IN AGRICULTURE

by

A.E. Johnston<sup>1</sup> and P.R. Poulton<sup>2</sup>

<sup>1</sup> Lawes Trust Senior Fellow, Rothamsted Research, Harpenden, AL5 2JQ, UK.
<sup>2</sup> Visiting Scientist, Rothamsted Research, Harpenden, AL5 2JQ, UK.

Proceedings 757

Paper presented to the International Fertiliser Society at a Conference in Cambridge, UK, on 11<sup>th</sup> December 2014.

www.fertiliser-society.org

© 2014 International Fertiliser Society ISBN 978-0-85310-394-3 (ISSN 1466-1314)

## CONTENTS

Abstract	2
1. Introduction	4
2. Plant availability of soil and fertiliser phosphorus	5
2.1. Soil-plant interactions	5
2.2. Concentration of phosphorus in the soil solution	5
2.3. Movement of phosphorus to roots	6
2.4. Plant root systems and phosphorus uptake by roots	6
3. Progression in thinking about the behaviour of soil and	
fertiliser phosphorus	7
3.1. Work in the nineteenth century	7
3.2. Work in the early part of the twentieth century	8
3.3. 1950 to 1980, a period of change	8
3.4. A major change in direction	8
4. Current concepts describing the behaviour of soil and fertiliser	
phosphorus	9
4.1. Rate and reversible transfer of phosphorus between pools of	fsoil
phosphorus and the maintenance of plant-available soil phos	phorus 10
4.1.1. Evidence for the very long-term release of phosphorus	15
	15
5. Critical level of plant-available phosphorus in soil	20
5.1. The concept of the critical phosphorus level	20
5.2. Determining the critical level of plant-available phosphorus	in soil 21
5.5. Factors affecting the critical level of plant-available phospho	rus 22
5.3.1 Effect of soil organic matter	22
5.3.2 The effect of soil conditions and weather on critical soil	<i>LL</i>
phosphorus	23
6 Methods for assessing the efficiency of use of soil and fertiliser	_0
phosphorus	27
6.1. Yield and phosphorus uptake	27
6.1.1. Phosphorus recovery by the difference method	27
6.1.2. Phosphorus recovery by the balance method	28
6.1.3. Comparison of the difference and balance methods for	
determining P efficiency	28
7. Efficient use of phosphorus in agriculture	29
7.1. Phosphorus use efficiency on soils at the critical level of	
plant-available phosphorus	29
8. References	33
Related Proceedings of the Society	37
	- •