Phosphorus Fertiliser Applications to Cereals: Comparing different methods for use efficiency

David P. Wall & M. Plunkett

Environment Research Centre, Teagasc, Johnstown Castle, Co. Wexford, Ireland

1. Questions
- Can lower soil test P concentrations be maintained without the risk of declining crop production levels?
- Will targeted P fertiliser application methods increase P fertiliser use efficiency in crop production?

2. Introduction
- Rising P fertiliser prices and constrained P use under environmental legislation have led to reduced P fertiliser inputs on Irish farms and consequently reductions in soil P fertility on farms (Fig 1.)
- Current recommendations for arable crops to build-up and/or maintain soil test P (STP = Morgan’s Extractable P) concentration at a critical level (STP: 6.0 mg L⁻¹), may be unsustainable in the future.
- Different soil types will respond differently to ± P fertiliser balance in terms STP change over time*
- P use efficiency in arable farming systems needs to be increased to conserve finite P resources.

3. Methods
- Between 2010 & 2013 spring barley response to P fertiliser studies were conducted at 8 arable sites.
- Studies laid out in a randomised complete block design with 5 replications of each treatment.
- Treatments combined P fertiliser rate (0, 10, 20, 30, 40, 50, 60 kg ha⁻¹) and P fertiliser application method (broadcast & combine drilled, Fig 1).
- Grain and straw yield and P content were determined and the total P uptake was calculated.
- Soils were sampled at start and end of the season.
- Effects of P fertiliser rate and P application method, year and their interaction were statistically analysed.

4. Results
- The interaction of P fertiliser rate X application method was significant. Generally less P fertiliser was required with combined drilled vs. broadcast for similar grain yield.
- Combine drilling the P fertiliser at sowing time increased P uptake efficiency compared to broadcast application on soils with lower STP soils.
- No response to P fertiliser in spring barley at or above agronomic optimum STP level, except for site 7 in 2013.
- Further evaluation of the effects of soil type is required.

5. Conclusion
- Targeted P fertiliser methods can be used to achieve high crop yields with higher P efficiency on soils with suboptimal soil test P concentrations.

Table 1. Spring barley phosphorus response sites, showing initial soil test P levels, sowing date, optimum P fertiliser rate and corresponding grain yield, and % grain yield increase over control grain yield levels

<table>
<thead>
<tr>
<th>Site code</th>
<th>Year</th>
<th>Soil test P mg L⁻¹</th>
<th>P Index</th>
<th>Sowing Date</th>
<th>Optimum P fertiliser rate kg ha⁻¹</th>
<th>Grain yield %</th>
<th>% grain yield increase over control grain yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>WXJD38</td>
<td>2012</td>
<td>1.38</td>
<td>1</td>
<td>13 Mar</td>
<td>50</td>
<td>5.9</td>
<td>137%</td>
</tr>
<tr>
<td>WXJD3B</td>
<td>2013</td>
<td>1.88</td>
<td>1</td>
<td>5 Apr</td>
<td>40</td>
<td>5.6</td>
<td>121%</td>
</tr>
<tr>
<td>WXWG5B</td>
<td>2013</td>
<td>2.36</td>
<td>1</td>
<td>4 April</td>
<td>7</td>
<td>4.7</td>
<td>100%</td>
</tr>
<tr>
<td>WMJD5B</td>
<td>2010</td>
<td>2.42</td>
<td>1</td>
<td>16 Mar</td>
<td>20</td>
<td>7.4</td>
<td>80%</td>
</tr>
<tr>
<td>WMJD5B</td>
<td>2010</td>
<td>2.62</td>
<td>1</td>
<td>29 Mar</td>
<td>40</td>
<td>5.6</td>
<td>115%</td>
</tr>
<tr>
<td>WADC38</td>
<td>2013</td>
<td>13.93</td>
<td>4</td>
<td>3 Apr</td>
<td>20 kg applied</td>
<td>8.2</td>
<td>105%</td>
</tr>
<tr>
<td>WADC5B</td>
<td>2012</td>
<td>19.7</td>
<td>4</td>
<td>13 Mar</td>
<td>100</td>
<td>16.0</td>
<td>100%</td>
</tr>
</tbody>
</table>

* Morgan’s extractable P is the standard agronomic soil test used in Ireland.

P Index: 1. 0-3.00 mg L⁻¹, 2. 3.01-6.00 mg L⁻¹, 3. 0.01-10.00 mg L⁻¹, 4. > 10.00 mg L⁻¹ Morgan’s extractable P

All P fertiliser treatments were broadcast at sowing time, all optimum rates determined by significant differences between P application rates.