Lime and Phosphorus for maximum productivity

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Co Meath
Presentation outline

- Background
- Laboratory incubation study
- Long term P experiment
- Multisite field experiment
- Soil P and lime interaction
- Seasonal and annual effects of P
- N, P and lime interaction
Background

Food harvest 2020
High Yield & High Quality

Compatibility
Phosphorus use stats (Ireland)

Phosphorus fertilizer usage in Ireland (tonnes P)

Year

P fertilizer Input

Price

Price per tonne (euro)
Soil test P trends
2013 Data

Good Overall Fertility - Tillage:
Soil pH > 6.5; Soil P and K Index 3 or 4

Optimum
14%

86%
Presentation outline

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Laboratory incubation study

16 soils chosen with contrasting soil texture, soil P levels (Morgan's) and soil pH

Soils incubated in pots
- Bulk density
- Constant moisture content
- Temperature
- Constant humidity
- In darkness

<table>
<thead>
<tr>
<th>Treatments</th>
<th>No Lime</th>
<th>+ Lime (t/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No P</td>
<td>0/0</td>
<td>0/5</td>
</tr>
<tr>
<td>+ P (kg/ha)</td>
<td>100/0</td>
<td>100/5</td>
</tr>
</tbody>
</table>
Laboratory incubation study results:

1. Only 4 - 31% of fertilizer P is recovered in the STP.

2. Lime also increased the STP.

3. Additive benefits of P and lime.
Influence of Aluminium

The graph shows the change in soil Al (mg kg$^{-1}$) across different treatments: Control, L, P, and P and L. The error bars indicate variability in the measurements. The graph suggests that treatment P results in a significant increase in soil Al, while the other treatments show no significant change or decrease.
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- Seasonal and annual effects of P
Long term P experiment

**Objective**
Examine the effect of P fertilizer on seasonal and annual grass production and herbage P concentration

**Experimental design**
JC dairy farm in 1995

clay loam (site 1)
sandy loam (site 2)

Phosphorus (16% TSP) 0, 15, 30, 45 kg ha yr\(^{-1}\)

**Harvest**
Between 6 and 8 harvests a year - DM yield and P concentration in herbage
Long term P experiment results (17 years)

**DM Yield**

14% increase in the herbage yield
Long term P experiment (effect of harvest)
Long term P experiment results (17 years)

*Herbage P concentration*
Presentation outline

Background

Laboratory incubation study

Long term P experiment

Multisite field experiment

Soil P and lime interaction

Seasonal and annual effects of P

N, P and lime interaction
Multisite field trial

**Treatments**

4x3x2 Factorial design = 24 plots (4 reps)

- **Phosphorus** - 0, 20, 40, 60 kg ha yr\(^{-1}\)
- **Nitrogen** - 0, 150, 300 kg ha yr\(^{-1}\)
- **Lime** - 0, 5 t ha (applied in year 1)

**2 sites**

Johnstown, Wexford (JC)
Moorepark, Cork (MP)

2011 - 4 harvests (Jun - Nov)
2012 - 8 harvests (full year)
Multisite field trial results

Cumulative herbage yield - Site 1

Phosphorus: 5.5% increase in the herbage yield (1214 kg DM ha\(^{-1}\))

Lime: 3% increase in herbage yield (568 kg DM ha\(^{-1}\))
Multisite field trial results

**Phosphorus**
- 5.7% increase in the herbage yield
  - (1244 kg DM ha\(^{-1}\))

**Lime**
- 2% decrease in herbage yield
  - (-526 kg DM ha\(^{-1}\))
### When was response to P most evident

<table>
<thead>
<tr>
<th>Harvest</th>
<th>Site 1</th>
<th>Site 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>P</td>
</tr>
<tr>
<td>1.1</td>
<td>&lt;.0001</td>
<td><strong>0.0004</strong></td>
</tr>
<tr>
<td>1.2</td>
<td>&lt;.0001</td>
<td>0.7721</td>
</tr>
<tr>
<td>1.3</td>
<td>&lt;.0001</td>
<td>0.1758</td>
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<tr>
<td>1.4</td>
<td>&lt;.0001</td>
<td>0.1981</td>
</tr>
<tr>
<td>2.1</td>
<td><strong>0.0135</strong></td>
<td>0.1256</td>
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<tr>
<td>2.2</td>
<td>&lt;.0001</td>
<td><strong>0.0267</strong></td>
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<tr>
<td>2.3</td>
<td>&lt;.0001</td>
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<tr>
<td>2.4</td>
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<td>0.0804</td>
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<td>&lt;.0001</td>
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<td>&lt;.0001</td>
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<td>2.8</td>
<td>&lt;.0001</td>
<td>0.7386</td>
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</table>
Herbage P interactions

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Site 1</th>
<th>Site 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>N*P</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$N_0$</td>
<td>$P_0$</td>
<td>0.36</td>
</tr>
<tr>
<td></td>
<td>$P_{20}$</td>
<td>0.37</td>
</tr>
<tr>
<td></td>
<td>$P_{40}$</td>
<td>0.37</td>
</tr>
<tr>
<td></td>
<td>$P_{60}$</td>
<td>0.38</td>
</tr>
<tr>
<td>$N_{150}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$P_0$</td>
<td>0.33</td>
</tr>
<tr>
<td></td>
<td>$P_{20}$</td>
<td>0.34</td>
</tr>
<tr>
<td></td>
<td>$P_{40}$</td>
<td>0.36</td>
</tr>
<tr>
<td></td>
<td>$P_{60}$</td>
<td>0.36</td>
</tr>
<tr>
<td>$N_{300}$</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>$P_0$</td>
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</tr>
<tr>
<td></td>
<td>$P_{20}$</td>
<td>0.34</td>
</tr>
<tr>
<td></td>
<td>$P_{40}$</td>
<td>0.35</td>
</tr>
<tr>
<td></td>
<td>$P_{60}$</td>
<td>0.37</td>
</tr>
<tr>
<td>Lime*P</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$L_0$</td>
<td>$P_0$</td>
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</tr>
<tr>
<td></td>
<td>$P_{20}$</td>
<td>0.36</td>
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<tr>
<td></td>
<td>$P_{40}$</td>
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<td></td>
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<tr>
<td>$L_5$</td>
<td>$P_0$</td>
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</tr>
<tr>
<td></td>
<td>$P_{20}$</td>
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<tr>
<td></td>
<td>$P_{40}$</td>
<td>0.35</td>
</tr>
<tr>
<td></td>
<td>$P_{60}$</td>
<td>0.35</td>
</tr>
</tbody>
</table>

Not significant
P timing – Grassland Trial

Importance of P for maintaining sufficient P in herbage

Splitting P fertiliser application increased the P concentration in herbage in July
Pound, shillings and pence

Assumptions;

• **Value of grass** - 150 €/tonne DM (Utilised)

• **Phosphorus fertiliser** - 2 €/kg

• **Ground limestone** - 25 €/tonne (spread)
Lime

5 t ha = 125€ ha

Equals 70kg P = 140 €

Cost over four years = (125/4) 31 €

Cost benefit **109 €/ha? (On P only)**

110 kg DM per harvest (7 harvests, 770 kg)= 116 €/year

Application of 15 kg = 30 € worth of P fertilizer

Cost benefit **86 €/ha**
1200 kg ha due to P application

180 € more grass

40 kg P fertiliser - Cost 80 €

*Cost benefit 100 €/ha*

How many ha do you have?
Summary

Laboratory incubation
- Lime will reduce P requirement

Long term P experiment
- 15% yield increase + mid season drop

Multisite field experiment
- P for early growth and maintain herbage P content
3 take home messages – How to save! £$

1. Optimising P fertilizer increased DM production by over 5%

2. P fertilizer and lime go hand in hand for maximising grass production

3. High N fertilizer use will dilute herbage P concentration
Research to Advice

The work of this project is contributing to development of Teagasc Soil Fertility Management Advice & Knowledge Transfer initiatives.

Acknowledgments

Supervisors
Technicians
Farmers
Students
3 take home messages – How to save!

1. Optimising P fertilizer increased DM production by over 5%

2. Further work required to quantify the mineralisation of organic P fractions

3. P fertilizer and lime go hand in hand for maximising grass production