Crop enhancements

John Haywood
Director

Unium Biosciences
Current Global Reach

- Commercial
- Registration / Trials
- Production sites

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Technology Partners

Intrinsyx Bio
University of Washington
Duke University
University of California
University of Texas
University of Montana
University of New Mexico
University of Chicago
University of Kwazulu-Natal
Rothamsted
ACG

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Technology Platforms

Key Criteria for development:
- Peer reviewable data
- Proof of concept data
- Field trials
- Soft Chemistry
- Integratable Affordable
- Practical
## Brand Platforms

<table>
<thead>
<tr>
<th>Platform</th>
<th>Technology</th>
<th>Brand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seed Treatments</td>
<td>Biostimulant Based Technologies</td>
<td></td>
</tr>
<tr>
<td>Biologicals</td>
<td>Endophyte – all crops Inoculants – pulse crops</td>
<td></td>
</tr>
<tr>
<td>Metabolites</td>
<td>2 x C3 &amp; 2 x C4 N metabolites 4-oxo chlorophyll boosting metabolite 3 Krebs Cycle metabolites 3 Carbohydrate metabolism promoters - T6P</td>
<td></td>
</tr>
<tr>
<td>Biostimulants</td>
<td>Potassium and Calcium Phosphite Amino Acids , SAR technologies</td>
<td></td>
</tr>
<tr>
<td>Nutrient Enhancers</td>
<td>Nitrogen, Phosphorus and Potassium nutrient use efficiency materials</td>
<td></td>
</tr>
<tr>
<td>Nutrients</td>
<td>Potassium, Sulphur, Boron and amino acid complexed trace elements</td>
<td>AMINOPLEX</td>
</tr>
<tr>
<td>Adjuvants-Enhancers</td>
<td>Biological Drought Stress Mitigation</td>
<td>tbc</td>
</tr>
</tbody>
</table>
From Concept to Farm Solution

Research and Discovery
Review of peer reviewable research or proprietary development

Proof of Concept
Working with leading Institutes to prove the concept and solution

Development & Farmer Experiences
Integrate the technology with customer programmes and farmer experiences

Replicated Research
Repeat the proof of concept in a field situation

Launch
After a minimum of 2 years data plan for launch

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Biological / Biostimulant / Nutrient Opportunities

Seed Vigour
Seed treatment
Root Development

Biological Supply
P fertiliser
Fertiliser Coating

Seed Production
T0
T1
T2
T3

SUPPLY
ASSIMILATION
UTILISATION

Prepare Seed
Maximise Carbohydrate Utilisation
Minimise Stress
Maximise N Assimilation
Remove Stress Disease Impacts

Tiros
Exseed
Calfite
Scyon

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UK Technology Screening

University / Institute Proof of Concept

CropSure
Envirofield
F1 seeds
LSPB
Greencrop
OAT
Posnan University
University College Dublin
SRUC

Replicated Field Trials

www.uniumbioscience.com
Replicated plots covering

a. Academy Blocks  
b. Programmes  
c. T0 Options  
d. T1 Options  
e. T2 Options  
f. T3 Options  
g. Biologicals  
h. Soil biology priming  
i. Trehalose pathway  
j. P & K  
k. Formulation developments
Products Solutions for Consideration

- Graphite Based Seed Treatment (farmer applied)
- Tarbis – Foliar Bacterial Endophytes for N&P use Efficiency
- Scyon – Nutritional Crop Health
- Twoxo – Nitrogen Assimilation
- 3Alo T6P – Carbohydrate Management
Graphite Biostimulant ST

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Experience 2

Cover crop
Day 14

Treated  Untreated  Treated  Untreated  Treated  Untreated
Tarbis

- **What is it?**
  - A unique consortia of two bacterial endophytes from the University of Washington.

- **What does it do?**
  - The two strains compliment each other and are designed to fix atmospheric nitrogen and to solubilise and sequester phosphorus for a wide range of crops.
  - They also increase the uptake of other nutrients to help the plant maintain nutritional balance (stoichiometry).
  - Reduce the impacts of abiotic stress and increase the recovery time especially from drought stress.

- **How does it do it?**
  - The endophytes colonise and move within the vascular system of the plant ensuring full crop coverage very quickly.

- **Features**
  - Increased root biomass
  - Increased Nutrient uptake especially N, P and K
  - Increased N assimilation

- **Benefits**
  - Enhanced N supply to the crop and increased assimilation within the crop
  - Increased phosphorus delivery to the plant at key growth stages
  - Ability to deliver key nutrients efficiently at key timings
  - Increased leaf protein
  - Increased nutrient use efficiency
  - Increased soil microbial health and biomass
  - Enhanced Yield / Quality

### CROP OPTIMUM TIMING ** DOSE ** L/Ha

<table>
<thead>
<tr>
<th>CROP</th>
<th>OPTIMUM TIMING **</th>
<th>DOSE ** L/Ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter Cereals</td>
<td>GS30</td>
<td>1.0 L/Ha</td>
</tr>
<tr>
<td>Spring Cereals</td>
<td>Early to mid tillering</td>
<td>1.0 L/Ha</td>
</tr>
<tr>
<td>OSR</td>
<td>Onset of spring growth</td>
<td>1.0 L/Ha</td>
</tr>
<tr>
<td>Potatoes *</td>
<td>Meeting along the row</td>
<td>1.0 L/Ha</td>
</tr>
<tr>
<td>Sugar Beet</td>
<td>3-6 leaf stage</td>
<td>1.0 L/Ha</td>
</tr>
<tr>
<td>Maize *</td>
<td>2-4 leaf stage</td>
<td>1.0 L/Ha</td>
</tr>
<tr>
<td>Vegetables</td>
<td>Pre transplanting or early post transplanting</td>
<td>1.0 L/Ha</td>
</tr>
<tr>
<td>Grassland</td>
<td>Onset of spring growth or once final cut has been made pre autumn</td>
<td>1.0 L/Ha</td>
</tr>
</tbody>
</table>

* Can be applied in the furrow at planting/drilling
** Can be applied either side of the optimum timing if sufficient crop cover

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Nitrogen Dose Response Interactions with Foliar Tiros 2020

The Effects of Foliar Tarbis on Winter Wheat Yield across a Nitrogen Dose Response Curve
Suffolk 2020

N = Urea coated with Nutrisphere
MU = methylene urea foliar N
**What is it?**
- A Unique blend of 2 peer reviewed technologies;
- 2-oxo glutaramate (2 oxo) – the original award winning technology from Dr P Unkefer (Los Alamos National Laboratory) which coordinates a plants nitrogen assimilation with its carbon fixation. Unique to UBS
- L-PGA (Pyroglutamic acid (L-PGA) or Pidolic Acid) – a functional analogue of 2 oxo, it converts in the plant to 2 oxo

**What does it do?**
- The unique combination work synergistically to enhance nutrient use efficiency, increasing the assimilation of nitrogen coordinated with increased carbon dioxide fixation from photosynthesis.
- It is proven 2-oxo is superior to L-PGA, but the combination outperforms either separately.

**How does it do it?**
- **Features**
  - Increased root biomass
  - Increased fertiliser uptake
  - Increased N assimilation
  - Increased Photosynthesis = increased CO₂ fixation
- **Benefits**
  - Increased growth – tillers
  - Increased leaf protein
  - Increased nutrient use efficiency
  - Increased seeds / ear
  - Increased soil microbial biomass
  - Enhanced Yield / Quality

**CROP TIMING DOSE ~ L/Ha**

<table>
<thead>
<tr>
<th>CROP</th>
<th>TIMING</th>
<th>DOSE ~ L/Ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cereals</td>
<td>GS 30 – 32 (trials optimum GS31) *</td>
<td>1.0</td>
</tr>
<tr>
<td>OSR</td>
<td>GB – Mid Flowering (trials optimum *)</td>
<td>1.0</td>
</tr>
<tr>
<td>Potatoes</td>
<td>Onset &amp; Mid Bulking *</td>
<td>1.0 x 2</td>
</tr>
</tbody>
</table>

* Can be applied alone or with liquid N fertiliser
Increased Nitrogen Assimilation on Wheat

- Take Off enhanced nutrient acquisition and assimilation
- This was the original brand for the technology of LANL
Scyon

- **What is it?**
  - A unique 50% calcium phosphite formulation in combination with L-PGA to enhance optimise nutrient use efficiency

- **What does it do?**
  - Its an efficient foliar delivery of phosphorus and calcium fertiliser containing 19%v P$_2$O$_5$ and 11% Ca based on the phosphite form of P.
  - It has a lowest salt index of all phosphites making it the safest formulation.
  - Its stabilised formulation ensures the phosphite stays as phosphite and is not oxidise to phosphate.

- **How does it do it?**
  - The phosphite component “tricks” the plant into a phosphorus deficiency situation, so the plant plant respond by increasing root length, biomass and importantly activity (exudation)

- **Features**
  - Increased root biomass, root length, root exudation
  - Increased N assimilation via L-PGA
  - Increased Photosynthesis = increased CO$_2$ fixation
  - Safest, most tank-mixable, effective phosphite on the market
  - Peer reviewed as the most effective PO$_3$ formulation to give confidence
  - The very small particle size increases solubility and uptake

- **Benefits**
  - Increased phosphorus delivery to the plant through increased root exudation
  - Increased phosphorus use efficiency
  - Increased soil microbial health and biomass
  - Lowest chance of crop phyto
  - Convenient formulation for tank mixing - Unique ability to mix with copper
  - Enhanced Yield / Quality

**CROP** | **TIMING** | **DOSE ~ L/Ha**
--- | --- | ---
Cereals | Foliarly at key growth stages | 1.0 - 2.0 L/Ha for most apps
Cereal | Foliarly at key growth stages | 1.0 - 2.0 L/Ha for most apps
OSR | Panting and foliarly at key growth stages | 1.0 - 2.0 L/Ha for most apps
Potatoes | Foliarly at key growth stages | 1.0 - 2.0 L/Ha for most apps
Sugar & Fodder Beet | Foliarly at key growth stages | 1.0 - 2.0 L/Ha for most apps
Pulses | Foliarly 2nd leaf and onset of flowering | 1.0 L/Ha for most apps
Maize | GS 13-16 (add Zinc due to P lock-up) | 1.0 L/Ha for most apps
Fruit | Foliarly at key growth stages | 2.0 - 3.0 L/Ha for most apps
Vegetables | Planting and foliarly at key growth stages | 1.0 - 2.0 L/Ha for most apps
Grass & ForageCrops | GS 12 - 16 | 1.0 L/Ha for most apps
How Scyon Works?

Normal Conditions

With Scyon

Metabolic Stimulation extended
Nutritional Balance Maintained

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Leaf Health GS 37

Standard Farm Practice

SFP + Scyon

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SKYFALL
EXTASE
PALLADIUM
TAPESTRY
FITZROY
DAWNSUM
INSITOR
DAWSUM
CHAMPION
REDWALD

FUNGICIDE
T0 : Teb 0.5
T1 : Revystar 1.0 + Prothio 0.4
T2 : Aquino 1.25 + Syrex 0.63
T3 : Teb 0.5 + Prothio 0.4

BIOLOGICAL+NUTRITION
T0 : CROPBOOST Mn,Zn,Mg,P,K
T1 : SCYON + Mn,Mg,Cu,Zn
T2 : KIROL PGA + S,Mg,B
T3 : 3ALO T6P + Mg,B,S,K
What is it?
A unique carbohydrate signalling complex comprising T6P designed to enhance carbohydrate management within plants.

What does it do?
- The unique combination work synergistically to enhance the storage and transportation of sugars within the plant
- It is one of the the critical mechanisms linking carbon assimilation and the growth of plants
- It mitigates plant stress caused by adverse environmental factors.
- In the growing parts of the plant the level of T6P signals how much sucrose is available for growth and accumulation of storage reserves.
- It also impacts on development transitions within plant physiology e.g. flowering leads to seed formation by linking development to sugar supply T6P supports plants to maximise yield without running our of carbon before seed production is finished.

How does it do it?
- Through a process known as “neofunctionalism” excess sucrose produced in photosynthesis is diverted to newly fixed carbon and amino acids.

Features.
- Enhanced root development
- Increased shoot biomass
- Critical for optimal crop physiology
- Enhanced carbohydrate management
- Increase chlorophyll production and prolonged photosynthesis

Benefits
- Improved photosynthetic capacity providing higher levels of sugar for growth and development
- Improved tolerance to stress esp' drought by partitioning sugars more efficiently to maintain crop growth / yields
- Enhanced Yield / Quality
- Enhanced seed quality
- Increased crop profitability

<table>
<thead>
<tr>
<th>CROP</th>
<th>TIMING</th>
<th>DOSE ~ L/Ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cereals</td>
<td>GS 39 - 65 (trials optimum GS59)</td>
<td>1.0</td>
</tr>
<tr>
<td>OSR</td>
<td>GB – Mid Flowering (trials optimum)</td>
<td>1.0</td>
</tr>
<tr>
<td>Potatoes</td>
<td>Onset &amp; Mid Bulking</td>
<td>1.0 x 2</td>
</tr>
<tr>
<td>Maize</td>
<td>6 leaf stage</td>
<td>1.0</td>
</tr>
<tr>
<td>Pulses</td>
<td>Onset of flowering</td>
<td>1.0</td>
</tr>
</tbody>
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Stress relative to Flowering

Key timing was T2

<table>
<thead>
<tr>
<th>Time</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unt</td>
<td>6.1</td>
</tr>
<tr>
<td>T6P T2</td>
<td>6.6</td>
</tr>
<tr>
<td>T6P T3</td>
<td>6.5</td>
</tr>
<tr>
<td>T6P T2&amp;T3</td>
<td>6.7</td>
</tr>
</tbody>
</table>
The neutral or negative responses were all on manganese deficient crops, repeated in potatoes – so 2020 recs will include a note on Mn and boron sufficiency as this process is heavily dependent upon Mn/Boron availability.
<table>
<thead>
<tr>
<th>Element</th>
<th>Untreated</th>
<th>3Alo T6P Treated</th>
<th>% Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>2.19</td>
<td>2.35</td>
<td>+7%</td>
</tr>
<tr>
<td>P</td>
<td>0.3</td>
<td>0.39</td>
<td>+30%</td>
</tr>
<tr>
<td>K</td>
<td>0.51</td>
<td>0.53</td>
<td>+4%</td>
</tr>
<tr>
<td>S</td>
<td>0.14</td>
<td>0.15</td>
<td>+7%</td>
</tr>
<tr>
<td>Mg</td>
<td>0.11</td>
<td>0.14</td>
<td>+27%</td>
</tr>
<tr>
<td>Ca</td>
<td>0.04</td>
<td>0.05</td>
<td>+25%</td>
</tr>
<tr>
<td>Fe</td>
<td>37</td>
<td>48</td>
<td>+30%</td>
</tr>
<tr>
<td>Mn</td>
<td>37</td>
<td>44</td>
<td>+19%</td>
</tr>
<tr>
<td>Zn</td>
<td>19</td>
<td>24</td>
<td>+26%</td>
</tr>
<tr>
<td>Cu</td>
<td>3.2</td>
<td>4.2</td>
<td>+31%</td>
</tr>
<tr>
<td>B</td>
<td>1.0</td>
<td>1.1</td>
<td>+10%</td>
</tr>
<tr>
<td>Mo</td>
<td>0.7</td>
<td>1</td>
<td>+43%</td>
</tr>
</tbody>
</table>
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