Examining the latest developments in seed treatment

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Seeds are:

- One of the most valuable resources on the globe
- The carrier of the genetic potential for crop productivity, improvement and diversification
- In many crops, the means of propagation
- As grain, the source for food, feed, fiber and fuel and other biomaterials
- A highly regulated high value commodity
- Highly attractive for diseases and pests, which affect yield and quality
Increasing demand for higher yields

**Biotic Stress**
- Insects
- Seed & soil borne diseases
- Nematodes

**Abiotic Stress**
- Heat / drought
- Wet / cold
- Nutrient deficiency

**Yield**

**Plant Genetics**
Seed Treatment: small chemical amounts, big effects!

- Product right on the target
- Uniform plant-to-plant loading
- Continuous delivery from formulation around seed
- Low environmental impact
- Convenient application
Seed Application

Different seed properties

Maize
40 - 60 m² / 100 kg

Wheat
80 m² / 100 kg

Oil seed rape
300 - 350 m² / 100 kg

Application technology
Seed Testing Methods

- Seed Flow test
- Dust-off tests
- Plantability tests
- Germination tests
- Seed loading analysis
The global seed treatment market is growing

- NAFTA: increasing ST technology level
- LATAM: leveraging GMO penetration
- EAME: expansion into Eastern Europe
- APAC: gaining momentum in emerging Asia

- Corn, OSR / Canola: towards 100% ST adoption by seed co’s; increasing technology level
- Soybeans: significant treatment move from on-farm to seed co’s, fungicides, insecticides, nematicides
- Rice: new wave of seed treatment adoption

Source: Syngenta Seedcare estimate
### Current seed applied fungicide compounds

<table>
<thead>
<tr>
<th>Chemical Family</th>
<th>Manufacturer</th>
<th>Active Ingredient</th>
<th>Key Brands</th>
<th>Major Crops</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triazole</td>
<td>Bayer CropScience</td>
<td>Triadimenol</td>
<td>Baytan</td>
<td>Cotton, Cereals</td>
</tr>
<tr>
<td>Triazole</td>
<td>Bayer CropScience</td>
<td>Tebuconazole</td>
<td>Raxil</td>
<td>Cereals, Maize</td>
</tr>
<tr>
<td>Triazole</td>
<td>Bayer CropScience</td>
<td>Prothioconazole</td>
<td>Redigo, Lombardor</td>
<td>Cereals</td>
</tr>
<tr>
<td>Triazole</td>
<td>BASF</td>
<td>Triticonazole</td>
<td>Charter</td>
<td>Cereals, corn</td>
</tr>
<tr>
<td>Triazole</td>
<td>syngenta</td>
<td>Difenoconazole</td>
<td>Dividend</td>
<td>Cereals</td>
</tr>
<tr>
<td>Strobilurin</td>
<td>syngenta</td>
<td>Azoxystrobin</td>
<td>Dynasty</td>
<td>Maize</td>
</tr>
<tr>
<td>Strobilurin</td>
<td>Bayer CropScience</td>
<td>Trifloxystrobin</td>
<td>Trilex</td>
<td>Maize, Soybeans, Cotton, Peanuts, Rice</td>
</tr>
<tr>
<td>Strobilurin</td>
<td>BASF</td>
<td>Pyraclostrobin</td>
<td>Stamina</td>
<td>Maize, Soybeans</td>
</tr>
</tbody>
</table>

**Diseases are complex:** seed, soil or air borne or combinations thereof. Hence may require multiple a.i. products for efficient, complete and economic control.
Fusarium diseases cycle – infection timing

Contribution of limitation through seed treatment

Evidence for systemic growth of Fusarium spp. or the translocation of mycotoxins

Infected seedlings

Seed- and soil-borne infection

Ear infection directly from crop residues or the leaves
## Current seed applied insecticide compounds

<table>
<thead>
<tr>
<th>Chemical Family</th>
<th>Manufacturer</th>
<th>Active Ingredient</th>
<th>Key Brands</th>
<th>Major Crops</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neonicotinoid</td>
<td>Bayer CropScience</td>
<td>Imidacloprid</td>
<td>Gaucho</td>
<td>Maize, Soybean, Canola, Sorghum</td>
</tr>
<tr>
<td>Neonicotinoid</td>
<td>Syngenta</td>
<td>Thiamethoxam</td>
<td>Cruiser</td>
<td>Maize, Soybean, Canola, Sorghum</td>
</tr>
<tr>
<td>Neonicotinoid</td>
<td>Bayer CropScience</td>
<td>Clothianidin</td>
<td>Poncho</td>
<td>Maize</td>
</tr>
<tr>
<td>Neonicotinoid</td>
<td>Nippon Soda Co., Ltd.</td>
<td>Acetamiprid</td>
<td>Vault</td>
<td>Canola</td>
</tr>
<tr>
<td>Phenylpyrazole</td>
<td>BASF The Chemical Company</td>
<td>Fipronil</td>
<td>Standak</td>
<td>Maize, Sunflower, Cereals, Rice, Cotton, Vegetables</td>
</tr>
<tr>
<td>Carbamate</td>
<td>Bayer CropScience</td>
<td>Methiocarb</td>
<td>Mesurol</td>
<td>Maize, sugar beet</td>
</tr>
<tr>
<td>Carbamate</td>
<td>Bayer CropScience</td>
<td>Thiodicarb</td>
<td>CropStar</td>
<td>Corn, Cotton</td>
</tr>
</tbody>
</table>

**Insect are root or stem/leaf feeding or sucking:** The neonicotinoides revolutionized the pest control through being broad spectrum and systemic allowing the replacement of early foliar sprays and granule applications by targeted control via seed treatment.
Seed Care nematicides –
A new seed treatment technology platform

<table>
<thead>
<tr>
<th>Company</th>
<th>Compound</th>
<th>Key Brand</th>
<th>Crops</th>
</tr>
</thead>
<tbody>
<tr>
<td>Syngenta</td>
<td>Abamectin</td>
<td>Avicta 1)</td>
<td>corn, cotton, soybeans</td>
</tr>
<tr>
<td>Bayer CropScience</td>
<td>Bacillus firmus</td>
<td>Votivo 2)</td>
<td>corn, cotton, soybeans</td>
</tr>
<tr>
<td>Monsanto</td>
<td>Natural protein</td>
<td>Harpin 3)</td>
<td>corn, cotton, soybeans</td>
</tr>
</tbody>
</table>

Nematode control is a new product category in seed treatment:
Spectrum: Free living nematodes:

1) MoA by killing of nematodes
2) MoA by forming a living penetration barrier
3) MoA by activation of natural auto defense mechanism
Seed Care nematicides at work

Soybeans
Mato Grosso State – High nematode infestation

Effects of control:
• Root Mass
• Stalk Quality
• N Deficiency Reduction
Seed Care: nematode control

Dry beans - insect control

Control

Treated

Untreated
Complete solutions are changing the market paradigm

...a step change in performance, completeness and convenience!
**Biologicals gain momentum again**

<table>
<thead>
<tr>
<th>Biological Control Agent</th>
<th>Product</th>
<th>Target (s)</th>
<th>Crop (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pseudomonas fluorescens</td>
<td>Biocoat</td>
<td><em>Fusarium oxysporum</em></td>
<td>Radish</td>
</tr>
<tr>
<td>Bacillus subtilis</td>
<td>Kodiak</td>
<td><em>Fusarium spp.</em> <em>Rhizoctonia solani</em></td>
<td>Cotton</td>
</tr>
<tr>
<td>Bacillus subtilis</td>
<td>FZB24</td>
<td><em>Rhizoctonia solani</em></td>
<td>Potatoes, other</td>
</tr>
<tr>
<td>Trichoderma spp.</td>
<td>Various</td>
<td>Soilborne diseases</td>
<td>Various</td>
</tr>
<tr>
<td>Pseudomonas chlororaphis</td>
<td>Cedomon / Cerall</td>
<td>Seedborne diseases</td>
<td>Cereals</td>
</tr>
<tr>
<td>Gliocladium virens</td>
<td>GlioGard</td>
<td>Soilborne diseases</td>
<td>Vegetables</td>
</tr>
<tr>
<td>Streptomyces griseoviridis</td>
<td>Mycostop</td>
<td>Soilborne diseases</td>
<td>Vegetables</td>
</tr>
<tr>
<td>Bacillus firmus</td>
<td>Votivo</td>
<td>Nematodes</td>
<td>Various</td>
</tr>
</tbody>
</table>
## Functional seed treatment is too

<table>
<thead>
<tr>
<th>Functionality</th>
<th>Applications</th>
<th>Trends</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Colorants</strong></td>
<td>Quality, branding, coding</td>
<td>• Customized offers</td>
</tr>
<tr>
<td><strong>Polymers</strong></td>
<td>Flowability, plantability, dust-off</td>
<td>• built-in formulations</td>
</tr>
<tr>
<td><strong>Rhizobia</strong></td>
<td>Enhancement of nitrogen fixation in legumes, soybeans</td>
<td>• Selection of adapted and improved strains • Improvement of shelf-life • Compatibility w. chemicals</td>
</tr>
<tr>
<td><strong>Micronutrients</strong></td>
<td>Balancing critical deficiencies • Zinc, Manganese • Molybdenum</td>
<td>• Customized offers</td>
</tr>
<tr>
<td><strong>Phytohormones</strong></td>
<td>Germination enhancement, stress tolerance, propagation and hybridization (development of synthetic seeds)</td>
<td>• Development of synthetic seeds</td>
</tr>
</tbody>
</table>
……for enhancement of plant performance

**Plant life**

**Needs**

- **Pest control**
  - Traditional SC (seed applied fungicides, insecticides, nematicides)
  - 3–5 weeks

- **Extended SC pest control**
  - 6–10 weeks by controlled delivery

- **Crop enhancement (CE)**
  - (e.g., water optimization, nitrogen use efficiency, improved plant establishment)
  - 3–5 weeks
  - 6–10 weeks

**New SC frontiers**
Quality assurance and stewardship are critical

Shared responsibility along the supply chain

1. Seed processing
2. Product formulation
3. Recipes & application
4. Supply chain & on farm
5. At planting

Short term
- Stewardship programs
- Applying regulatory requirements
- Gaining back suspended registrations
- Identifying best polymers

Mid-term
- Certification of seed processing from harvest to planting
- Novel in-line process monitoring tools

Long term
- Research in improvements in application technologies
Summary

- The Seed Treatment market is in a dynamic growth phase:
  - Increasing awareness of benefits in emerging markets
  - Nematode control as new product category is now established
  - Functional seed treatment technologies getting more important
  - Crop enhancement and performance are pushing the frontiers

- The value of seed continuously increasing
  - One seed – one plant is new paradigm

- Innovation, quality and safety are key
Thank you

Bringing plant potential to life