Role of Innovation in Additives Technology
To Meet New Demands of Agricultural Plastics

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Major Benefits of Plasticulture To The Growers

• Extension of growing seasons in unfavorable geographic regions.

• Allowing the production of warm weather crops in regions where the natural environment is not conducive for such growth.

• Allowing a more precise application of fertilizer and irrigation schedule.

• Reducing the use of pesticides.

• Creating a safer environment for workers.
Three Most Important Variables To Control

• Light
• Temperature, and
• Humidity
Role of Additives

Additives provide to Plastics:

• Stabilization
  — To retain the original molecular architecture of the polymer under the effect heat, light etc.

and

• Functionalization
  — To provide additional attributes to the polymer which add value for end use application.
Innovations In Stabilization And Functionalization

• Stabilization
  – Protection of Agro plastics from detrimental effects of UV radiation, and heat during actual usage.

• Functionalization
  – Absorption and boosting of different wavelengths of light to optimize crop growth and quality.
  – Selective filtering of UV light for habitat modification of insects or to improve the quality of crops.
  – Maximize light transmission by keeping plastic films free of dust, condensates, algae etc.
  – Use of light, heat and microorganisms to manage Agro related plastic wastes by triggering degradation after its useful life.

We Call it Total Light Management
Innovation In Stabilization:
NOR Technology Platform

• Low-Interacting Light Stabilizer:
  – Ag films are particularly vulnerable against UV radiation in the presence of aggressive chemicals.
  – Active sulfur and halogen functionalities interfere with most of the conventional light stabilizers (HALS).
  – NOR HALS provide excellent UV/Thermal/Chemical resistance, light transmission and durability.
  – NOR 371 is primarily positioned for sulfur burning greenhouses and for mulch films exposed to heavy dosages of pesticides.
  – In general, outstanding performance for any outdoor application exposed to acidic environment.
HALS/Chemicals Interactions

Nitrooxyl Radical Generation

Nitroxyl Radical Regenerative Denisov Cycle

R\(^1\) = H, Alkyl

Light, \(O_2\)

\(\text{H}^+, \text{S, Cl, Metals,...}\)

POSSIBLE DEACTIVATED PRODUCTS

\(\text{ROO}^\cdot\)
NOR HALS Stabilization Cycle

NOR is a non-interacting HALS

R\(^1\) = H, Alkyl

H, S, Cl, Metals,...

No Interference With NO\(^-\) generation

R\(_\cdot\)

ROO\(_\cdot\)
Protection of Ag-Films Under Critical Conditions

• Light stabilizer package selection is dependent on:
  – Local and specific conditions
    • Geographic location (kLys)
    • Type of Ag chemicals
    • Greenhouse design, type of mulch film etc.
    • Film construction (clamping, mono or multilayer)
    • Film thickness, type of resin etc.
    • Durability requirement
    • Film functionalization & special effects requirements

• Performance is confirmed by:
  – Artificial weathering
  – Experimental greenhouse test
  – Field data
Functionalization: Antivirus Additive CGX006

- Durable (100% UV blocking capability intact after 24 months).
- Blocks UV radiation making virus spreading insects disoriented by disabling their photoreceptors.
- Doesn’t interfere with bee pollination.
- Very selective wave length blocking.
- Prevents petal blackening.
- Synergistic in terms of product light stability when combined with NOR HALS.

- **Performance is confirmed by:**
  - Lab tests
  - Experimental Model Experiment
  - Field data
Wavelength Sensitivity for Pollinating Bees
Antivirus But Non-interfering with Pollinating Bees

Plastic with CGX006

Pollinating Bee sensitivity

Zone Still visible to Bees

% T

240 280 320 360 400 440 480 520 560 600 640 680 720 760 800 nm

UV Light

Visible Light
Functionalization: Selective Wavelength
Management By Photoluminescence

- Adds Value To Flower Production Under GH Cover:
  - By turning light which is not useful into one which is beneficial to certain crops.
**Ciba® SMARTLIGHT™ RL1000**: How does it work

Increases the amount of light useful for photosynthesis

Absorption spectrum of the extract of photosynthetic active pigments of a leaf (according to Mermier and Baille, 1998).

- **Conversion of UV light into Red light**
- **Blue and Red light contribute to photosynthesis**
Ciba®SMARTLIGHT™ RL1000: How does it work
Changes the quality of transmitted light…

- **Red/Far-Red ratio >1**
- **Red/Far-Red ratio** can influence physiological processes
- **Performance is independent of the sky condition**

*Red/Far-Red ratio for each polyethylene test film for different sky conditions (CI, Clearness Index)
Ciba®SMARTLIGHT™ RL1000: How does it work
Can add value to flower production under Greenhouse cover

• Through improvement in flower
  – longer, thicker stems or stronger bulbs

• Through increase in productivity
  – more roses for commercialization

• Through shortening of growing cycle
  – shorter time to market (crucial during periods of festivities like Valentine‘s or Mother‘s Day).

Agronomic performance is demonstrated at various locations across the globe via field trials. Commercial in Africa, Brazil. Ongoing trials in Colombia, Ecuador, Argentina, Mexico, Asia.
Smartlight Field Trials In Different Regions

BRAZIL

ARGENTINA

MEXICO

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Functionalization:
Making Plastics Degradable via Oxo-Biodegradable Process

• This additive is incorporated into regular polyolefins and causes plastic degradation by a two-step process:

Oxo-Biodegradation:
– **Step 1**: The plastic is photochemically, thermally oxidized during outdoor exposure.

– **Step 2**: Once the degradation process is initiated, it continues to do so even under the soil by microorganisms (bacteria and fungi) in the presence of moisture till it is completely degraded into CO$_2$, H$_2$O and biomass.
Ciba® Envirocare® AG1000: Benefits

- Works with the same incumbent resin as a drop-in additive.
- Same processing conditions for the film converter.
- Same physical/mechanical properties as the existing product.
- No change necessary in usage.
- Same effect on crops as the incumbent product.
- Film thickness reduction possible.
- Same logistics as the current supply chain.
- No ecotoxicity on present crop.
- No residual toxicity in the soil.
- Passes composting requirement (>58 °C).
- No collection, transport and disposal required.
- Very cost competitive with the non-degradable option.
Field Trial Results: Ciba® Envirocare® AG1000

Positive Experience so far with:

- Mulch Films For:
  - Corn
  - Melon, Watermelon, Gourd
  - Tomato, Lettuce
  - Asparagus, Pepper
  - Cotton

Planned trials with:

- Pineapple
- Strawberry
- Palm Tree

Other Applications Under Development:

- Banana sleeves, Drip tapes, Twines, Nettings, Row Covers etc.
Photos From The Field: Red Pepper in Florida

1.25 mil B/W mulch
Courtesy: Pliant Corporation

Early Stage

Advanced Stages

Plastic Additives © Ciba Specialty Chemicals
Photos From The Field: Banana, Pineapple

Banana sleeve

Banana sleeves, twines waste

Mulch waste in a pineapple field

Courtesy: Dole Corporation
Conclusions

- Many parameters including material and environmental play a role in determining the service life of Agroplastics. Choice of well-suited stabilizer package is very important.

- Functional additives can add new attributes on top of service life extension e.g. photoselectivity, degradability, antifog, antidrip, antidust, antivirus etc.

- Continuous innovation is of utmost necessity to meet the new demands of the market place.

- In agriculture, customers are typically risk averse. It takes long time to introduce new products in the market.

- Extensive field trials, strategic partnerships with various members of the value chain are necessary.

- Need considerable amount of dedicated resources to become successful.
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