INNOVATIVE FULLY BIODEGRADABLE MULCHING FILMS & FRUIT PROTECTION BAGS – LIFE+ MULTIBIOSOL PROJECT

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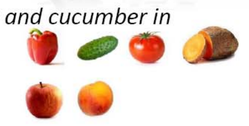
INTRODUCTION

Current existing semi-intensive and intensive farming practices require the use of large quantities of mulching film and fruit protection bags since they help prevent the growth of weeds, protect crops from insects, regulate soil and produce temperature and retain water and nutrients. Conventional non-degradable polymers, after single-use, become plastic waste and create a serious problem of waste management since it is time-consuming and expensive to recycle. This plastic waste is usually abandoned, incinerated or taken to a landfill with serious consequences for the environment in particular for soil contamination due to the long-lasting and detrimental degradation of polyolefin.
In order to overcome the environmental problems created by conventional agricultural plastics, the presented research has focused the attention on biodegradable polymers as an alternative.

Raw materials
-100% biodegradable
-Polymers based on natural sources

Production processes
-Materials extrusion
-Film blowing

Validation of plastics products in fields
-Tomato (Spain and France), pepper and cucumber in Spain and sweet potato in Belgium
-Bags for apple and peach (Spain)



Validation of plastics in laboratory
-Mechanical tests of materials
-Tests for certification OK BIODEGRADABLE SOIL

Validation of quality:
- Soil
-Crop (Pre-harvest)
- Product (Post-harvest)

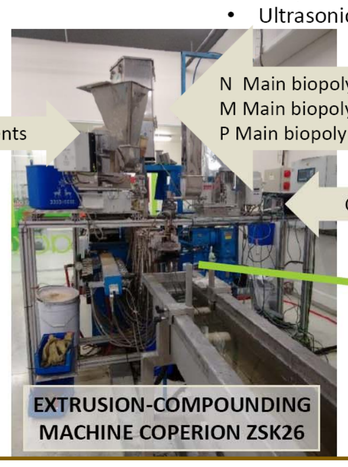
Expected results
- Reduction of plastic waste
- Less CO_2 emitted during the production of plastics/Non-emissions from disposal
- Improvement of soil quality
- Improvement in crop quality
- Certification OK BIODEGRADABLE SOIL

Transformation processes at AIITIP facilities

1 Extrusion compounding

Twin-screw extruder equipped with one gravimetric dosing for pellets, two for powder and one for liquids (1 to 100 Kg/h)
- Pelletizer and dryer on the same line.
- Adapted screws for several materials and additives
- Ultrasonic system of dispersion available

Oligo elements



N Main biopolymers AAPE
M Main biopolymer PHA-PLA
P Main biopolymer PBS

Carbon Black

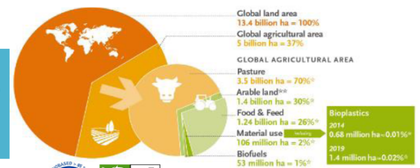
- ✓ Tª control
- ✓ Material flow control
- ✓ % components

EXTRUSION-COMPOUNDING MACHINE COPERION ZSK26

Moretto X DRY AIR T Minidryers

Raw materials selections

Renewable origin (biobased) refers to the origin of carbon atoms in polymers.



Are biobased — Biobased — *Are biobased and biodegradable*

Not biodegradable

Bioplastics *Eg biobased PE, PET, PTT*

Bioplastics *Eg PLA, PHA, PBS*

Biodegradable

Conventional plastics *Nearly all conventional plastics eg PE, PP, PET*

Bioplastics *Eg PBAT, PCL*

Are biodegradable

ce: European plastics

Not biodegradable

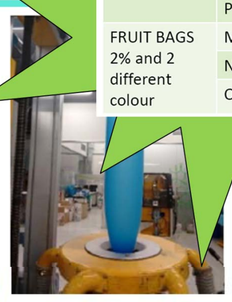
Glucose
- Ethanol -> Ethylene → Polyethylene (PE)
- Lactic acid -> Lactide → Polylactic acid
- Succinic acid, Butanediol → Polybutylene succinat (PBS)
- 1,3-Propanediol → Polytrimethylene terephthalate (PTT)
- Furandicarboxylic acid → Polyethylene furanoate (PEF)
- Polyhydroxyalkanoates (PHA)

Fatty acids from plant oils
- Dicarboxylic acids (e.g. azelaic acid) → Polyester (LCDA)

Biodegradation by microorganisms is a matter of polymer structure, not of carbon origin. Not oxo-biodegradable (Chemical degradation).

Samples (materials)		Thickness
MULCHING 3% oligoel.	M	M1-M3 2 thickness
	N	N1-N3 3 thickness
	P	P1-P3 1 thickness
FRUIT BAGS 2% and 2 different colour	M	M4-M7 40 µm
	N	N4-N6 35 µm
	O	O1-O3 50 µm

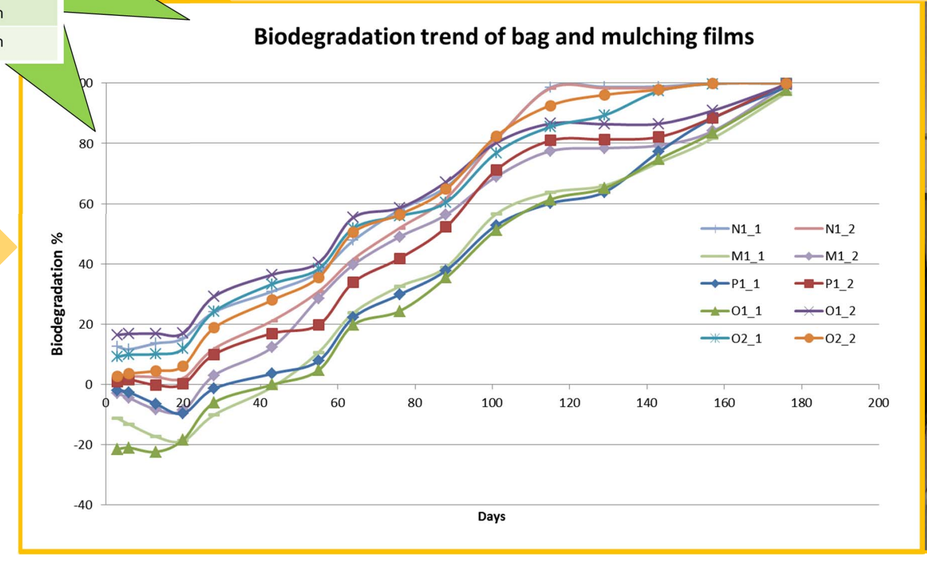
Samples production at AITIIP facilities



Mulching

Film for fruit bags

Biodegradation tests at ARCHA facilities



	Biodegr. % (mean and standard deviations)			
	After 143 days		After 176 days	
N1	98,8	± 0,28	99,9	± 0,0
M1	79,6	± 3,5	99,2	± 0,85
P1	76,4	± 4,1	97,9	± 1,8
O2	80,6	± 8,3	98,5	± 1,3
O3	97,6	± 0,35	99,9	± 0,0

Innovative formulations peculiarity:

- **Mulching film** necessarily have the characteristics of existing third-generation biodegradable film, but also include catered Oligoelements that best suit each particular type of crop (such as Zn, Cu and Mo have been shown to exert positive effects).
- **Innovative bags** for fruit protection have replicated the main characteristics of existing fruit protection bags but made of biodegradable material and with ergonomic design for easy and quick placement on fruit. The innovative fruit bags are enhanced with laser micro-perforation to allow the necessary elimination of water vapour created during fruit ripening on trees and different colours (semi-transparent/white options, red and blue) have been tested to evaluate specific performance to help protect crops against UV rays and to also cater specific photosynthetic capacities of each particular crop which can influence in the fruit final colour.

Materials and methods

BIOPLASTICS CHARACTERIZATION	Method
Tensile Properties of Thin Plastic Sheeting	ASTM D 882 – 12
Tear-Propagation Resistance of Plastic Film and Thin Sheeting by a Single-Tear Method	ASTM D 1938 –14
Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials	ASTM D 790 – 15
Plastics – Methods of exposure to laboratory light sources	EN:ISO 4892-3
Standard Test Method for Oxidative-Induction Time of Polyolefin by Differential Scanning Calorimetry	ASTM D3985 - 10
Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a Modulated Infrared Sensor	ASTM F1249 - 13
"OK Biodegradable Soil"	EN13432:2000

Heavy Metals concentration → > Limits (EN 13432) = Not accepted

Volatile solids concentration → > 50% = Not accepted

Biodegradation test on soil (ASTM D5988) → < 90% within 2 years

Final compost/ SOIL QUALITY → Chemical-physical parameters and heavy metal NOT comply with National or European limits for Regulation on fertilizers

Eco toxicological test on final composted residues → < 90% compared with blank sample

CONCLUSIONS

New formulations for Biomulching and Biobag films have been developed with the main characteristic of the reduction of plastic waste has been achieved due to the high percentages of biodegradability in soil (98-100% biodegradation in 176 days). Mechanical properties of bioplastics are similar to those of LDPE and Plant health, crop quality and nutritional content are similar to the obtained with conventional mulching.

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