# Effects of conventional and biodegradable mulches on soil chemical properties and plastic additive release in a short-term blueberry plantation in Southern Portugal

Filipe Pedra[1,#], Pedro Brás de Oliveira[1,*] and Corina Carranca[1,**]

1 Instituto Nacional de Investigação Agrária e Veterinária, Quinta do Marquês, Nova Oeiras, 2780-157 Oeiras, Portugal

* LEAF Linking Landscape, Environment, Agriculture And Food, Instituto Superior de Agronomia, Tapada da Ajuda, 1349-017 Lisboa, Portugal

** GREEN-IT Bioresources for Sustainability, ITQB NOVA, Av. da República, 2780-157 Oeiras, Portugal

Contact address: # filipe.pedra@iniav.pt

## 1. INTRODUCTION

**Plastic mulch in agriculture improves crop performance, but contains chemical additives (e.g., plasticizers, UV stabilizers, flame retardants, metals) that may leach into the soil.**

**Biodegradable films are promising alternatives to conventional fossil-based plastics, aiming to reduce environmental risks.**

**This study aimed to assess the potential impact of conventional plastic and biodegradable mulches on agricultural soil after one year of blueberry cultivation (2023–2024).**

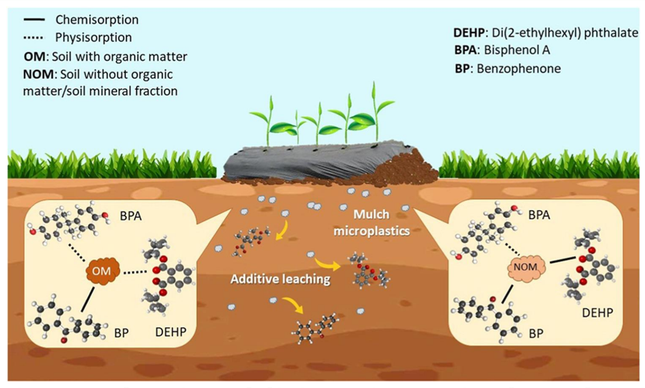


**Fig. 1. Plastic additives in agricultural soils.**
(Ramanayaka et al., Environ. Res., 2023.)

## 2. MATERIALS AND METHODS

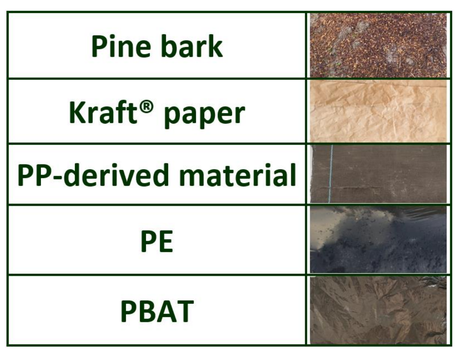


**Fig. 2. Mulching materials in the experiment.**

***Experimental site*: A field trial was conducted in a two-year blueberry plantation located in Southern Portugal.**

***Experimental design*: Randomized block design with five mulching treatments and 3 replicates (3 plants/replicate):**

- **Biodegradable materials: Pine bark, Kraft® paper, and Kritifil® biofilm (PBAT).**
- **Conventional plastics: polyethylene (PE) and a geotextile fabric (polyethylene (PP)-derived material).**

***Soil sampling:* Soil was sampled at a depth of 0–20 cm beneath each mulch type using a metallic soil auger, and the samples were stored in glass containers.**

***Soil analysis:* pH, organic C, and extractable Cu, Zn, Fe, and Mn were analyzed according to routine laboratory methods, and the DEHP additive, a phthalate, was determined using GC–MS.**

***Statistical analysis:* After one year of cultivation (2024), soil properties were compared among treatments using ANOVA one-way.**

## 3. RESULTS AND DISCUSSION

**Table 1. DEHP concentration in mulch materials**

| Material | mg/kg | Std. Dev. |
|---|---|---|
| Kraft® paper | 0.02 | 0.002 |
| PP-derived material | 32.3 | 7.64 |
| PE | 7.86 | 0.82 |
| PBAT | 2.64 | 0.52 |

**In Table 1:**

- **Kraft® paper had only trace concentration of DEHP, followed by PBAT (Kritifil®) biofilm.**
- **Conventional mulches, particularly the PP-derived material, exhibited much higher DEHP concentration in its composition.**

**Table 2. Soil chemical properties in the first year of cultivation**

| Treatment | pH | Organic C (g/kg) | Extractable Cu (mg/kg) | Extractable Zn (mg/kg) | Extractable Fe (mg/kg) | Extractable Mn (mg/kg) | DEHP (mg/kg) |
|---|---|---|---|---|---|---|---|
| Pine bark | 5.64±0.04 a | 13.8±0.3 a | 2.06±0.10 a | 2.50±0.13 ab | 163±32 a | 6.84±1.28 b | 0.123±0.034 a |
| Kraft® paper | 5.63±0.27 a | 12.0±1.3 a | 2.08±0.23 a | 2.19±0.05 b | 129±27 ab | 5.88±1.43 b | 0.095±0.065 a |
| PP-derived material | 5.80±0.27 a | 17.3±5.3 a | 1.76±0.29 a | 2.32±0.22 b | 126±26 ab | 7.12±1.13 b | 0.094±0.071 a |
| PE | 5.81±0.21 a | 13.7±1.8 a | 0.88±0.14 b | 2.76±0.07 a | 141±3 ab | 8.00±0.28 ab | 0.087±0.059 a |
| PBAT | 5.46±0.07 a | 14.4±3.5 a | 1.18±0.40 b | 2.50±0.17 ab | 103±23 b | 9.83±0.39 a | 0.065±0.014 a |

Means in the same column followed by the same letter are not significantly different ($p > 0.05$) by LSD test.

**After the first year of cultivation (Table 2):**

- **The different soil mulching materials did not cause significant changes in soil pH or organic carbon concentration.**
- **Significant differences were observed for soil extractable Cu, Zn, Fe, and Mn concentrations.**
- **PE and PBAT treatments resulted in significantly lower soil Cu concentrations. PE led to the highest Zn concentration, whereas PBAT caused the lowest extractable Fe levels and increased Mn availability.**
- **Soil concentrations of the phthalate additive (DEHP) did not vary significantly among treatments, although there was a slight tendency to be lower under Kraft® paper and PBAT biofilms. All values were below the contamination threshold in Portuguese agricultural soils (<5 mg/kg).**

## 4. CONCLUSIONS

- **Kraft® paper and Kritifil® biofilm (PBAT) showed the lowest concentrations of the phthalate additive (DEHP), reinforcing their potential as safer mulching alternatives.**
- **The very low DEHP concentrations in the mulching materials resulted in only trace levels of the contaminant in the underlying soil, even beneath the PP-derived mulch.**
- **The absence of a clear relationship between DEHP concentrations in the mulch materials and in the underlying soil suggests limited DEHP release, likely constrained by the slow degradation of the materials.**
- **Although limited to a short-term experiment, the results indicate that mulching materials may influence the availability of certain metals in soil.**
- **Long-term monitoring is needed to assess the impacts of different mulch types on soil chemical properties.**