Biodegradable liquid mulch for weed management

Products of biocircular economy in plant protection

PlastLife meeting 24-25.4.2024

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KUVA: STOCK.ADOBE.COM

LIFE21-IPE-FI-PlastLIFE
PlastLIFE-hanke saa EU:n LIFE-ohjelmasta rahoitusta, jolla hankkeen materiaalit on tuotettu. Materiaalien sisältö edustaa ainoastaan hankkeen omia näkemyksiä, joista CINEA/Euroopan komissio ei ole vastuussa.

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Need for sustainable replacements for black plastics and synthetic pesticides

- Risk for new weeds and pests growing
- The use of black polyethylene (PE) mulches and pesticides should be reduced

→ need for environmentally sustainable pest and weed management solutions

Fígure: https://china-plasticfilm.en.made-in-china.com/product/vByQrzWAZSpK/China-Black-Plastic-Strawberry-Mulch-Film-Agriculture.html
Figure: https://www.agric.wa.gov.au/grains/herbicide-application

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Biodegradable liquid mulch

- To be used in food production and green building for pest and weed management
- Replace use of plastic covers
- Replace use of pesticides (glyphosate)
- Based on biobased wood and other plant derived raw materials including pyrolysis liquids
- MULCH COMPOSITION, METHOD OF MANUFACTURING AND RELATED USES, Patent granted in Finland 15.2.2019, FI127775
  - Peat based mulch
  - Fiber based mulch: patent application in progress

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Liquid mulch efficiently prevents weed growth around the base of park trees

Without mulching

Glyphosate

Biodegradable liquid mulch

After 12 weeks

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Applications

- Agriculture
- Horticulture
- Tree nursery
- City parks
- Home gardens
- …

Research and testing

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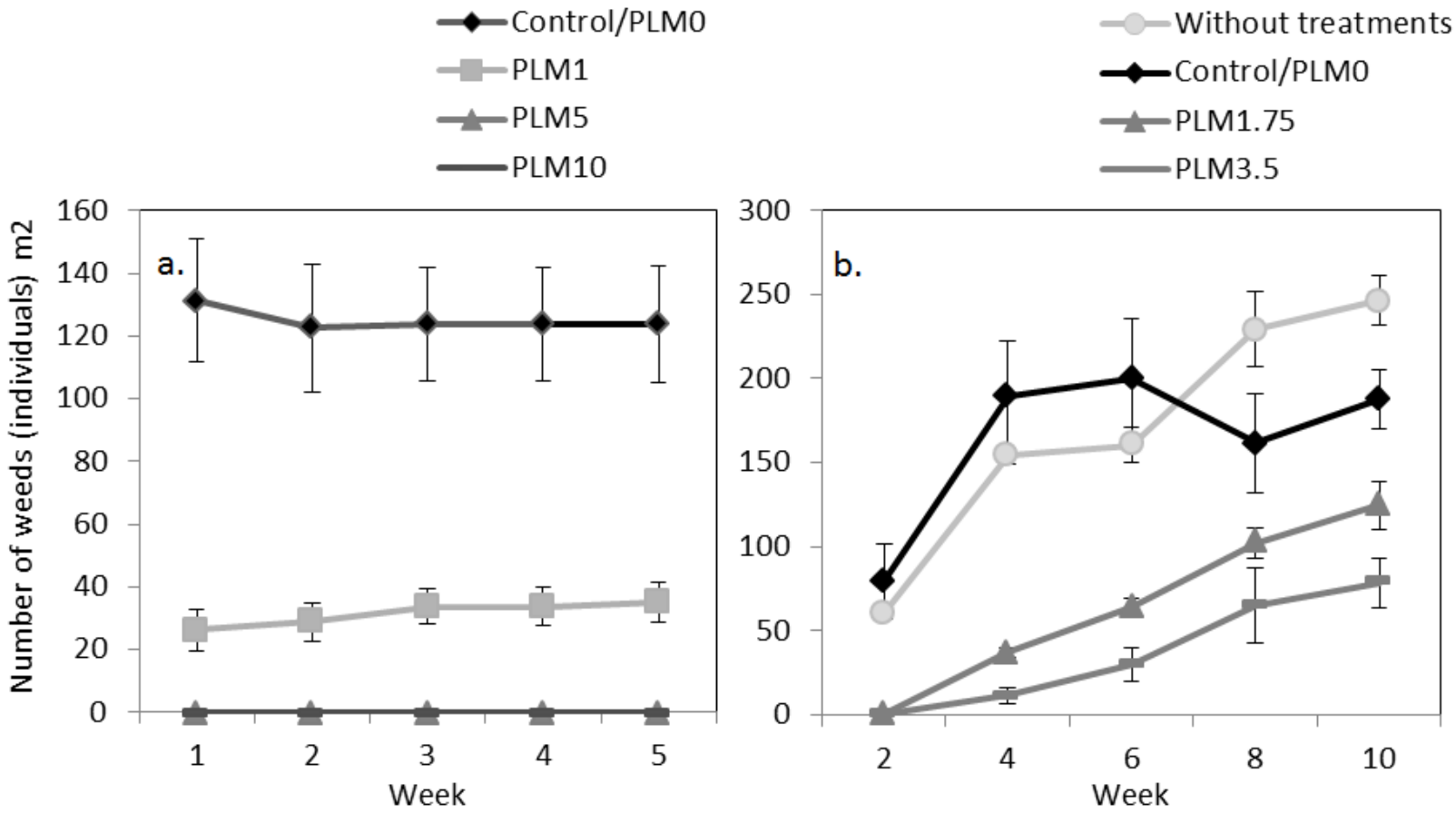
Effect of peat based mulch on weed growth

- Greenhouse experiment (left)
  - PLM1 (1% pyrolysis liquid)
    - weed biomass 72 – 80 % lower
    - > 1% PL no weeds
- Field experiment (right)
  - weed number 40% and 60% lower in PLM1.75 and PLM3.5



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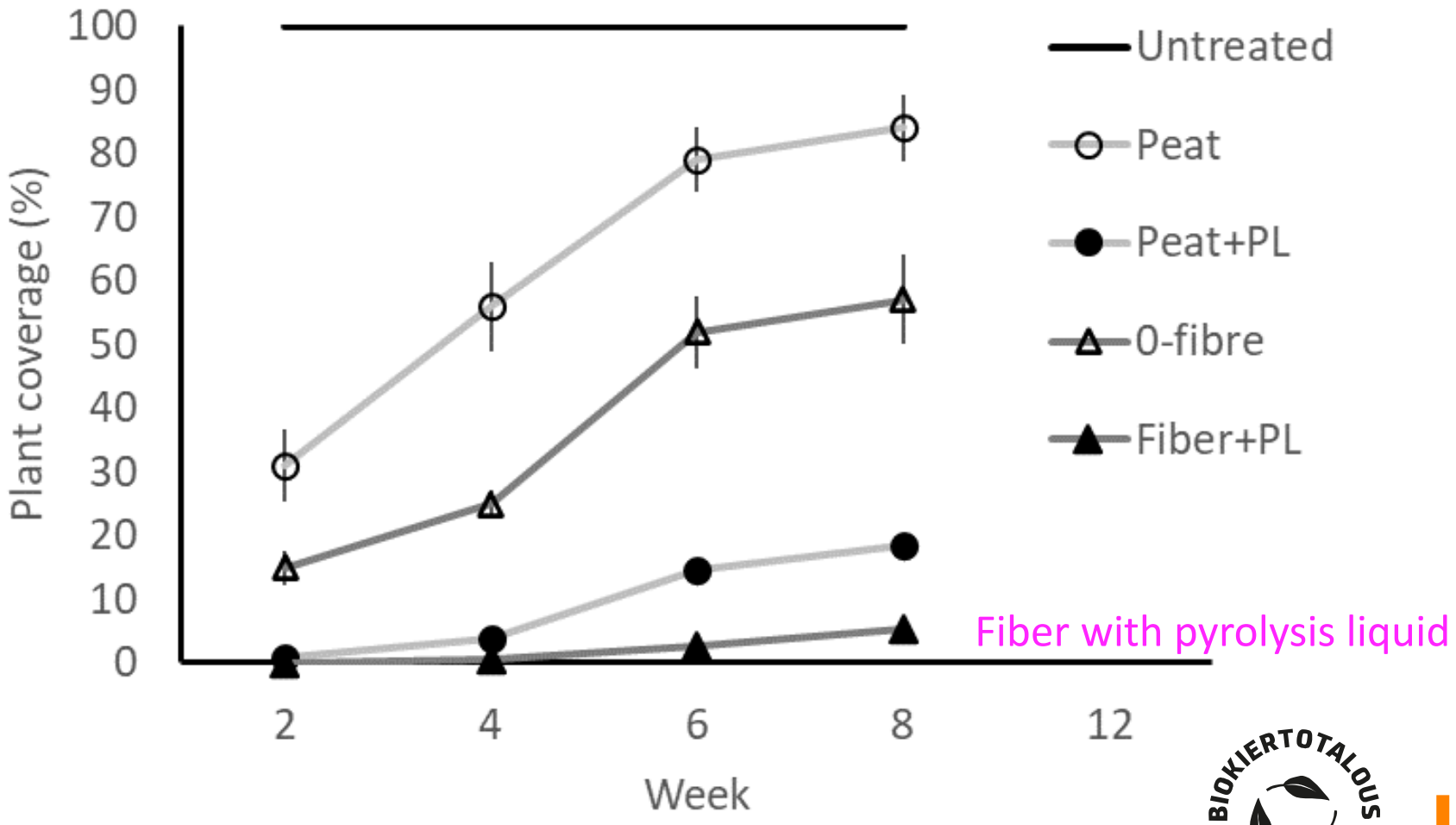
Pyrolysis liquid also improves performance of fiber mulch



Fiber with pyrolysis liquid

Apple garden/grass study

- Fiber, water and pyrolysis liquid were mixed in a bucket, spreading was done manually
- Similar mulch dose on each square

- Treatments with five replicates
  - 1) no mulch
  - 2) 2.5 % of PL
  - 3) 5.0 % of PL
  - 4) 2.5 % of AA (acetic acid)
  - 5) 5.0 % of AA

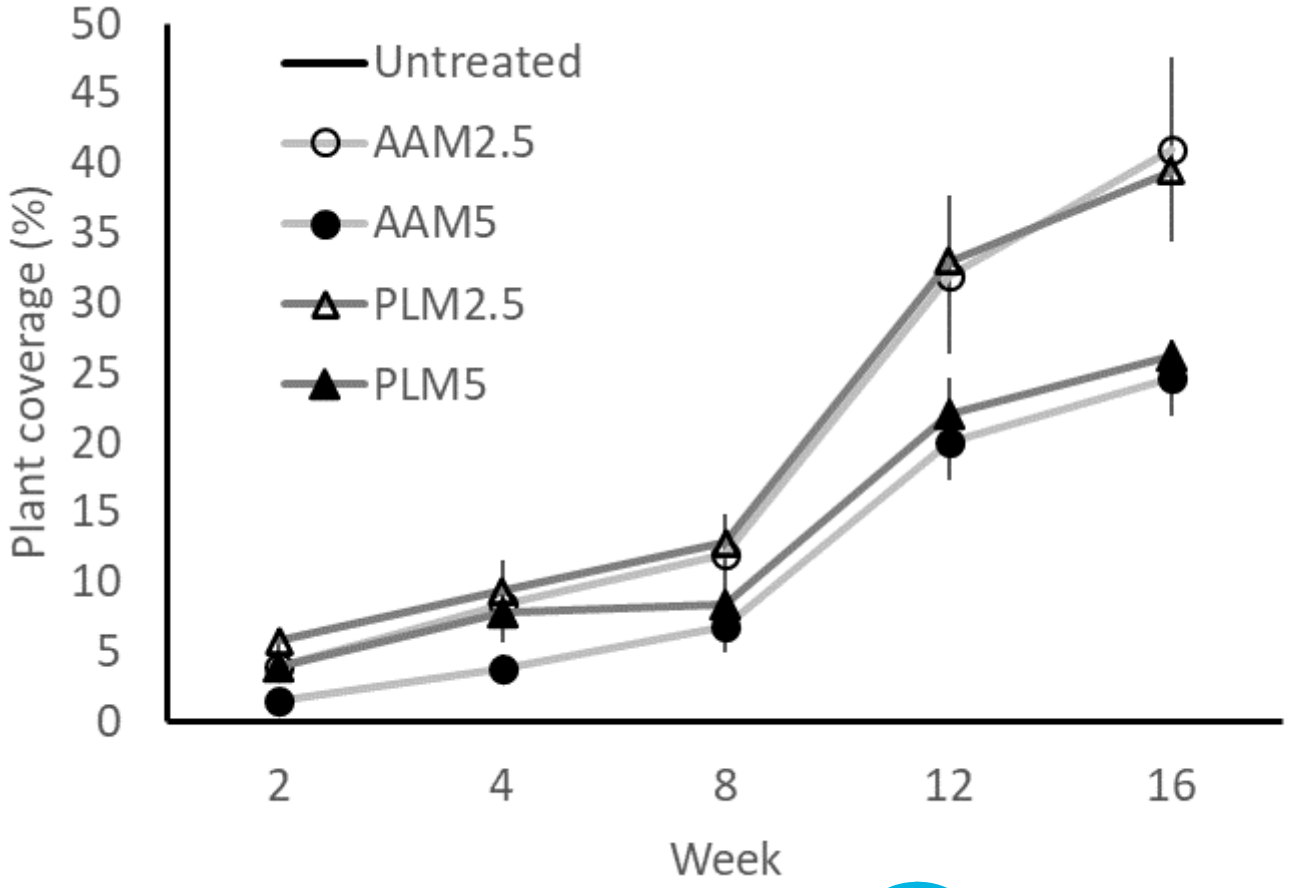
- Established May 2023, Jokioinen
- Weed coverage was estimated after 4, 8, 12 ja 16 weeks

- Scientific publication in progress

Apple garden/grass study

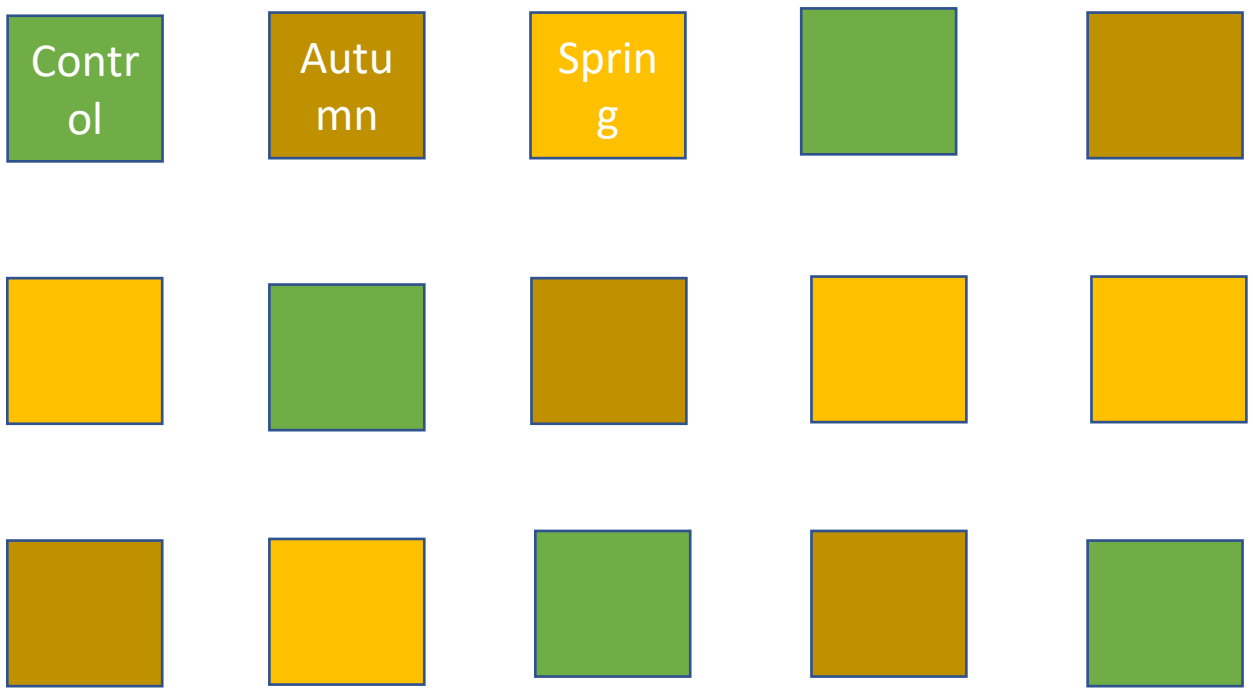
- Old grass is quite hard ”weed containing” envionment compared to agricultural fields
- 3 month: ca. 20 % plant coverage

  = 80 % ”weed growth” reduction in extremely hard weed pressure
- Increasing of pyrolysis liquid concentration from 2.5 → 5 % improves efficacy of mulch over time



Apple garden/grass study

- Winter hardiness?
- Mulch was spread either in the end (autumn 26.10.2023) or in the beginnig of growing period (spring 15.4.2024)
- Weed coverage estimation during growth period 2024



Study ongoing

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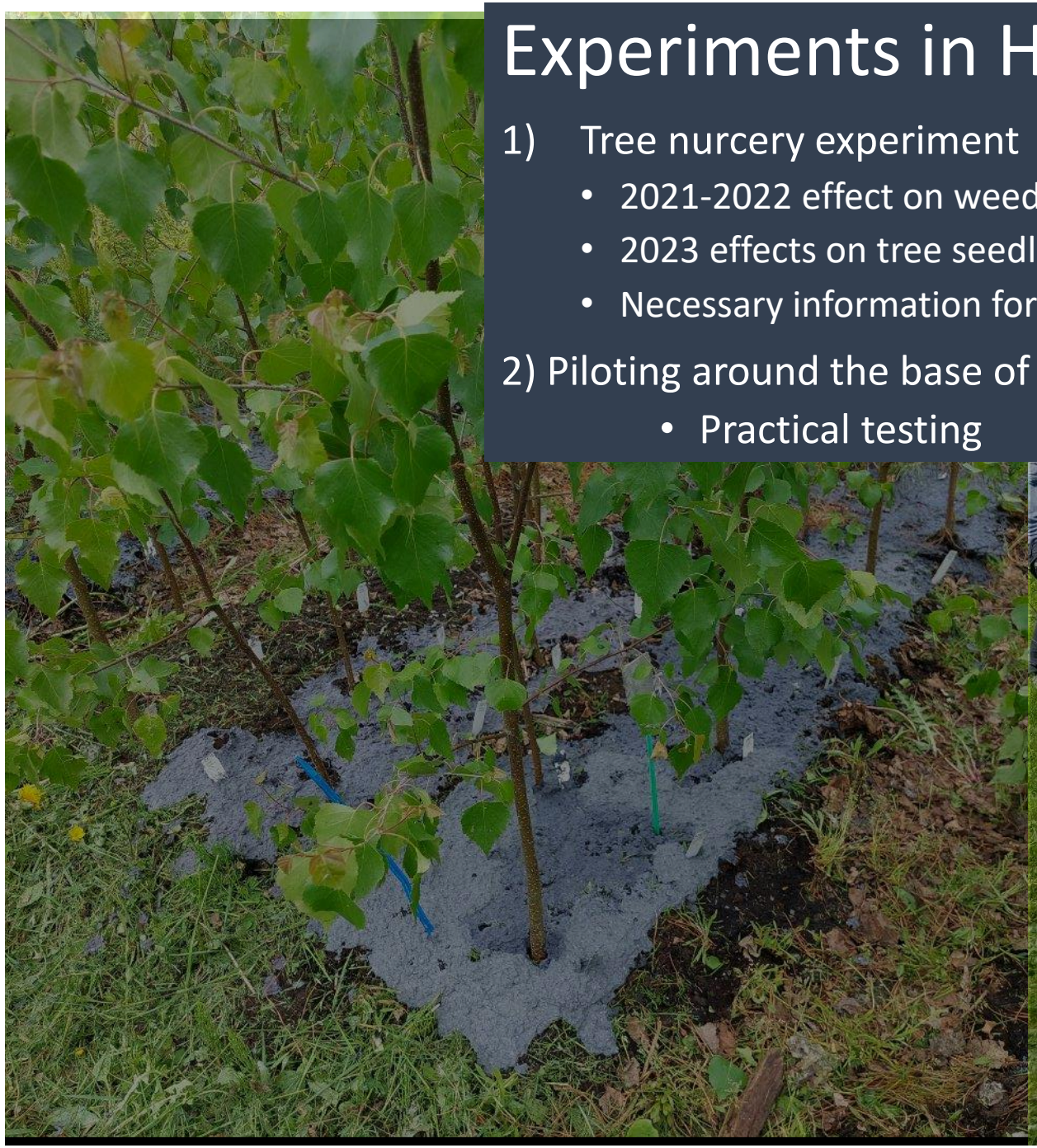
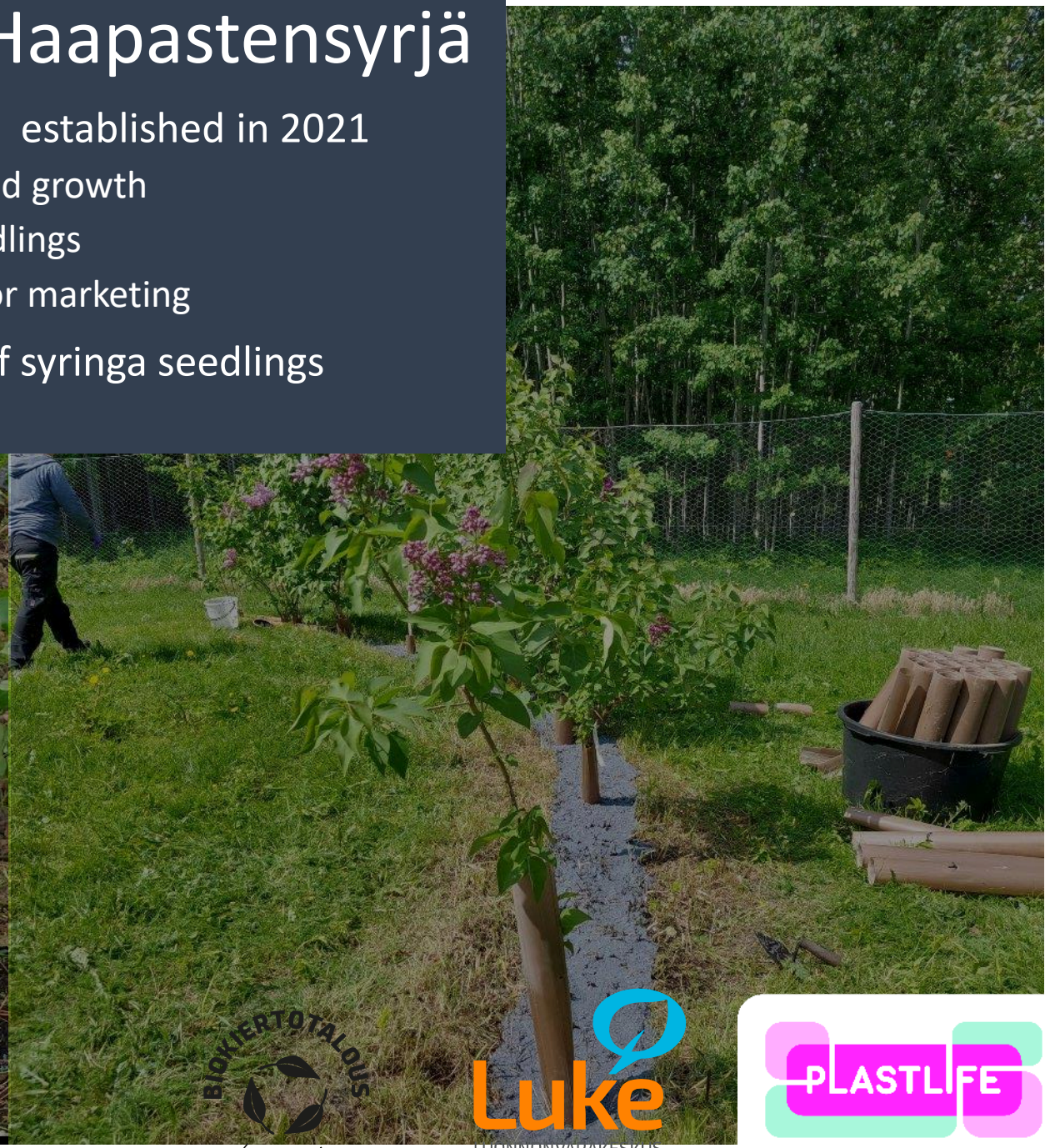
Testing in apple garden

- Around the base of the apple trees
  - Practical testing
  - Not scientific data

Experiments in Haapastensyrjä

1) Tree nurcery experiment established in 2021
   - 2021-2022 effect on weed growth
   - 2023 effects on tree seedlings
   - Necessary information for marketing
2) Piloting around the base of syringa seedlings
   - Practical testing





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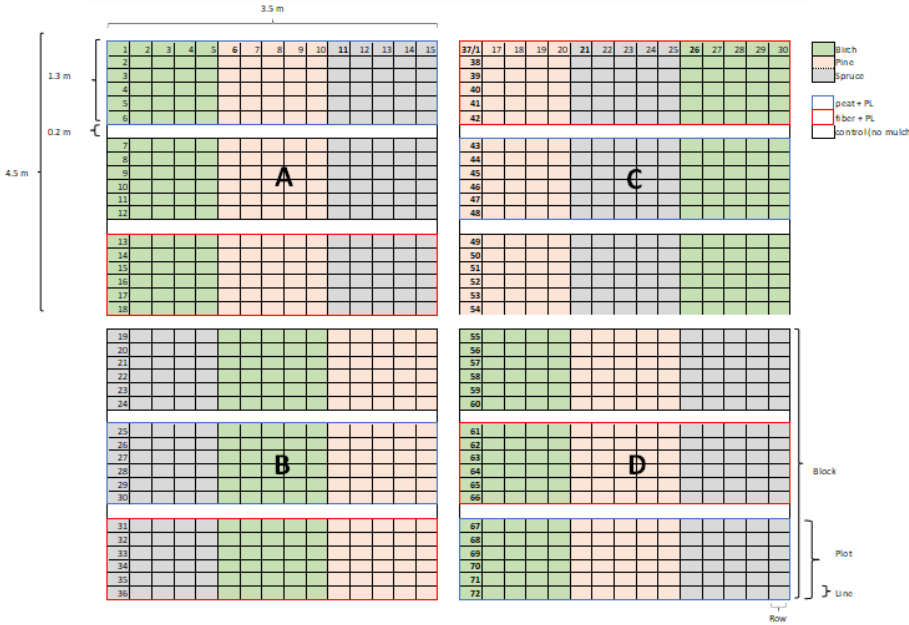
Haapastensyrjä: nursery experiment 2021

- Pine, spruce and birch seedlings
- Peat and fiber based mulches + (2 cm layer) + controls
- Pyrolysis liquid concentration 4 %
- Analyses
  - Weed uprooted and calculated after 6 ja 12 wk
  - Tree seedling height after growing periods 2021-2023
- 2023 mulch spread in contact to plants to see the effect of direct contact



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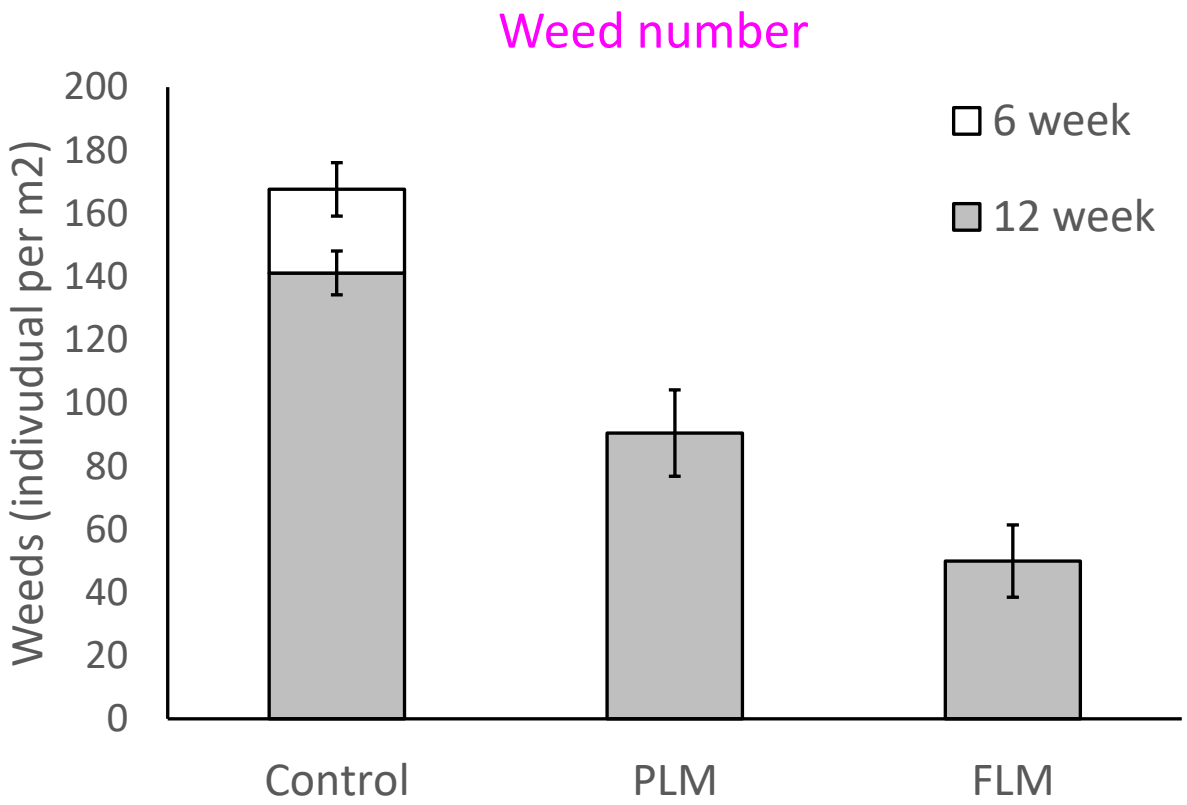
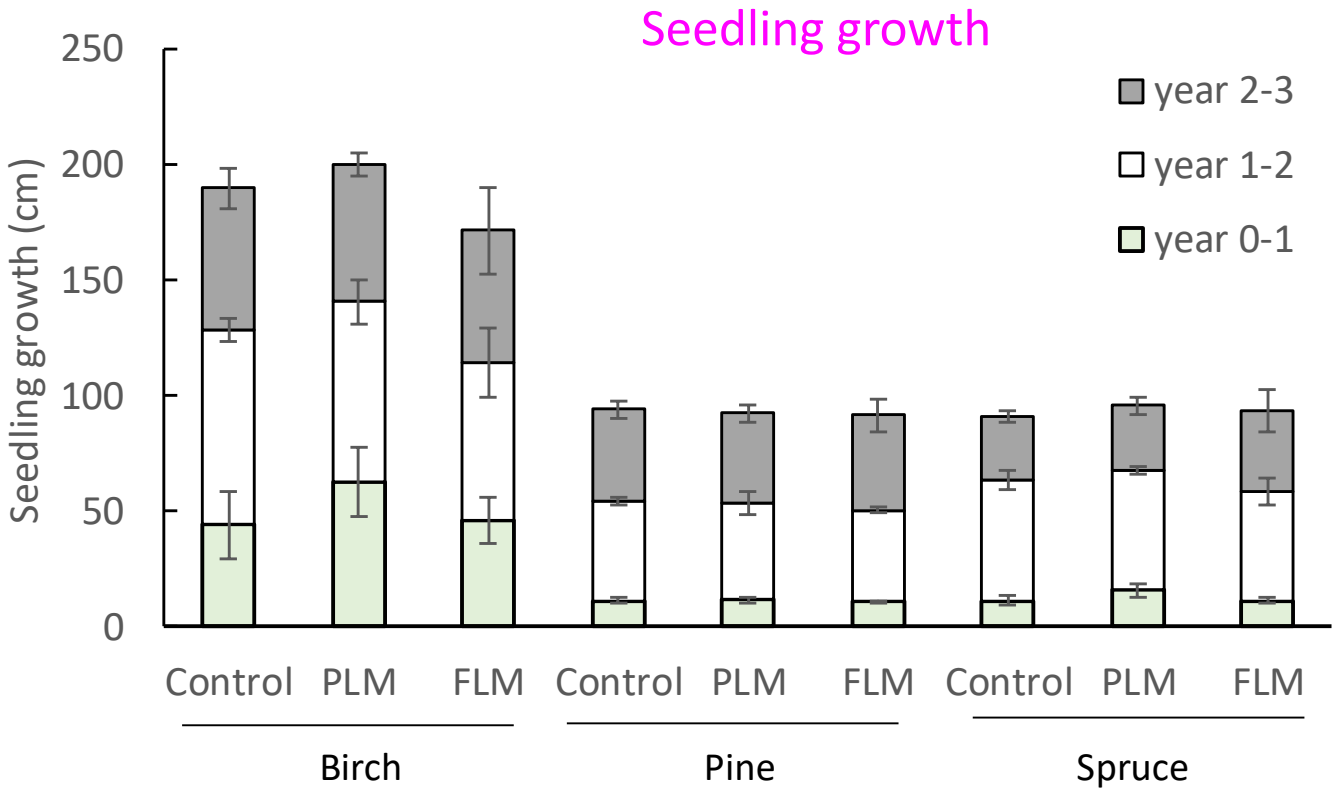
Haapasten(syrjä) nursery experiment

- 6 wk: weeds only in controls
- 12 wk: in fiber mulched sites 70 % lower and peat mulced sites 46% lower in compared to control
  - Statictic difference only between control and fiber mulch
- Expert assessment: mulching can reduce remarkably labour need for weed uprooting during growing period



Haapasten(syrjä) nursery experiment

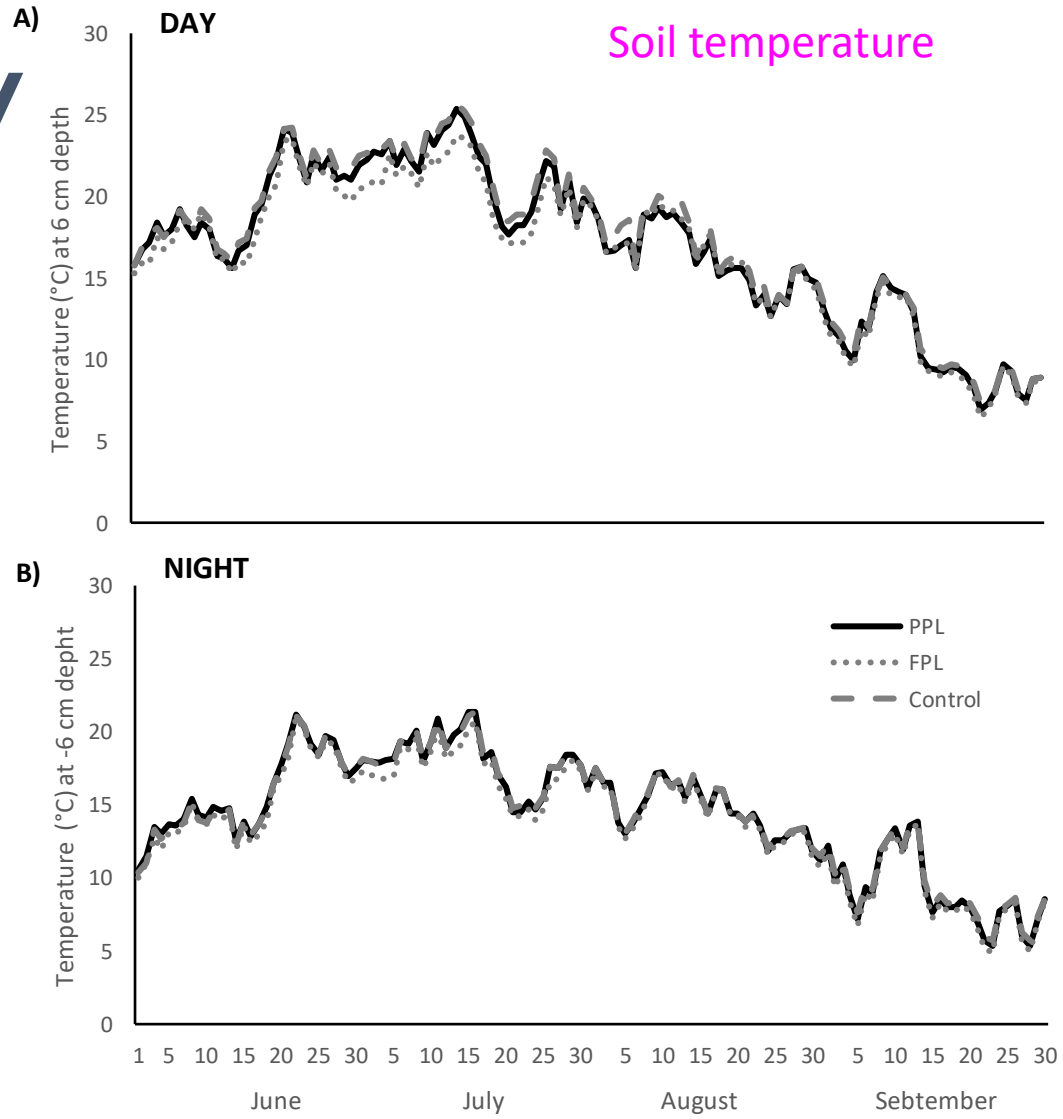
- During first spreading time of mulches the age of tree seedlings was 1-2 years
  - Two weeks period between mulching and planting
- With older seedlings: direct contact with mulch had no effect on plant seedlings
  - Only few seedlings died
- Visual esitimation: lighter birche leaves in fist year in fiber mulched sites?
  - Impacts on nitrogen availability?



Haapasten(syrjä) nursery experiment

- Soil temperature below mulches (-6 cm) measured in growth period 2021

- At day time temperature below fiber mulch 0.4-1.1°C lower
- At night time, similar trend, but not statically significant difference
- Fiber mulch WITHOUT colouring agents
  - Good or bad, depends on climate coditions!



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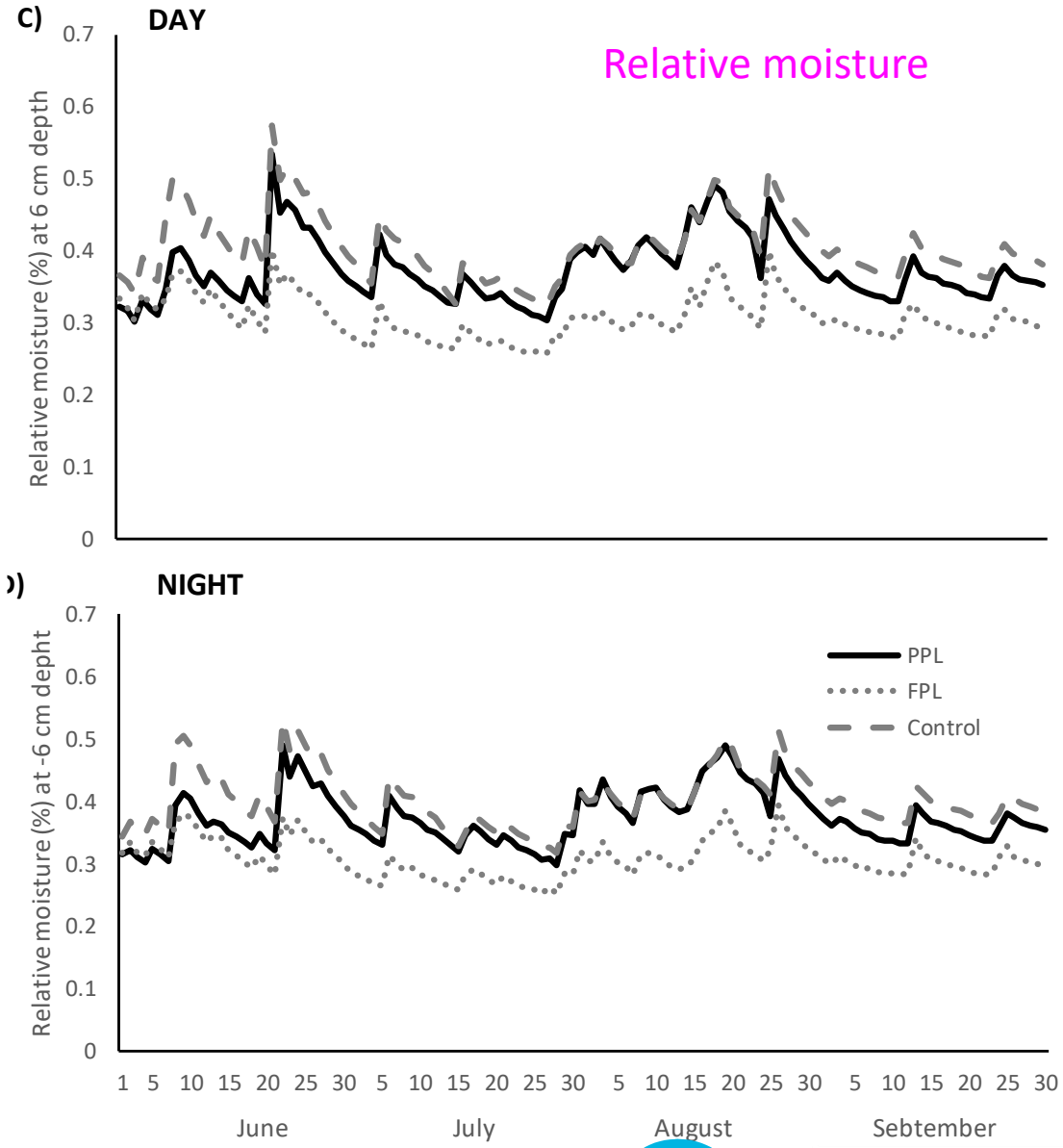
Haapasten(syrjä) nursery experiment

- Relative moisture content below mulch (-6 cm) during growing period 2021
- Relative moisture lower below fiber mulch
  - Difference between mulches not significant
- Top vs. below irrigation?
- Does difference matter → no differences in seedlings growt!



Laboratory piloting: colour, additives

Transparency, optimal moisture content, hardiness

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Spreading technology – development ongoing

- Development of spreding technology is one aim of PlastLife -project WP 5.4.1
  - Pilot scale unit developed
- Several technologies developed globally
- Spreading technology is not a bottle nect
  - Should be developed in specific conditions where used by utilizing exicting technologies

Evironmental issues?

- Biodegradation: readily biodegradable having 76% biodegradation during first 10 day
  - OECD (1992) guideline 301F
- Onion field experiment: PL concentration 350 ml/$m^{2,\ s}$oil samples after 1 and 3 months
  - No remains were found
- Field experiment: no differences on the abundance of soil nematodes or enchytraeids

- The sensitivity of different species on PL was variable among the taxa:
  - *D. magna* (EC50 155 mg L^{-1}) < *L. variegates* (LC50 176 mg L^{-1}) < *L.minor* (IC50 229-231 mg L^{-1}) < *D. rerio* (LC50 320 mg L^{-1}) < *A. aquaticus* (LC50 397 mg L^{-1}) < *S. gracilis* (LC50 > 381 mg L^{-1}) < *Lymnaea sp.* (LC50 866 mg L^{-1})
  - EC50 for juvenile production of *F. candida* was 5100 mg kg^{-1} (dw)
  - 14-day LC50 for *A. caliginosa* was 6560 mg kg^{-1} (dw)

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More details

- https://www.materiaalitkiertoon.fi//fi-FI/PlastLIFE
- https://youtu.be/Mv3WymrPrsU
- Hagner M et al. 2021. Weed Res 60:182- 193
  - https://doi.org/10.1111/wre.12411
- Hagner M et al. 2020. Environ Technol Inno 20:101154
  - https://doi.org/10.1016/j.eti.2020.101154
- MULCH COMPOSITION, METHOD OF MANUFACTURING AND RELATED USES, Patent granted in Finland 15.2.2019, FI127775
  - https://worldwide.espacenet.com/patent/search/family/060654964/publication/FI127775B?q=luonnonvarakeskus

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Thank you!

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