The Effects of Pesticides on Oxobiodegradable Agriculture Mulch Films

Kayla Snyder[1], Dr. Thamara Laredo[2], Dr. Christopher Murray[2]

1. MSc Candidate, Chemistry Lakehead Orillia
2. Department of Environmental Sustainability, Lakehead Orillia

Research Summary

Motive: The addition of pesticides was reported to change the controlled degradation of mulch films; controlling the degradation increases yields via protection during growth and prevents harm to crops during harvesting.
Objective: Determine if the application of pesticides affects degradation of oxobiodegradable mulch films.
Key Methodology: Samples of films were exposed to pesticides and exposed to different stressors; degradation was tracked and differences were used to further analyze pesticides.
Results: Likely that the pesticides act to further stabilize the films, as expected pesticides effects depend on structure.

Background[1,2]

Films are made from polyethylene and designed to degrade after a specific time

Benefits of plastic mulch:
- increased yields
- decreased germination
- decreased pests
- decreased water need
- economical benefits

Degradation is controlled through two steps
1. oxodegradation
2. biodegradation

Stabilizers prevent degradation
- UV screeners absorb energy
- antioxidants prevent propagation

Prodegradants speed up degradation once season is complete

Additives are manipulated to make films for different crops

Methodology


Small subset of field exposure

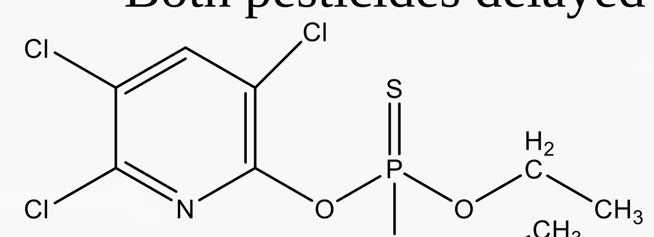

Film prior to exposure

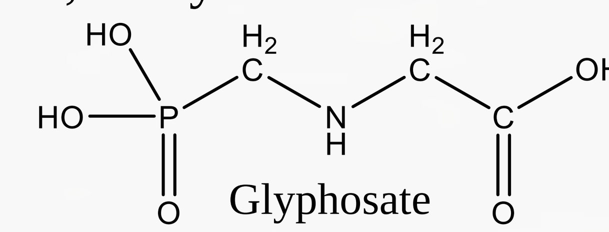

Film after exposure

- FTIR used to chemically measure degradation
- Analyzed differences in degradation in photo, thermal and field environment
- Measured UV absorbance, antioxidant capacity and computational calculations of pesticides to determine capacity to act as antioxidants and/or UV screeners

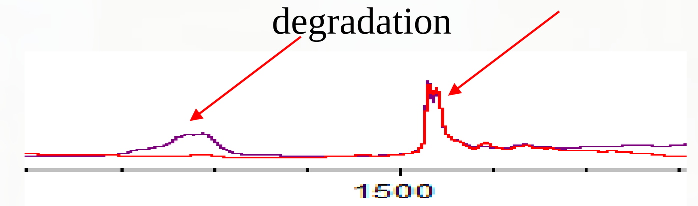
Results[3]

Both pesticides delayed degradation, likely act as stabilizers


Chlorpyrifos


Glyphosate

Monitoring degradation:
- Analyzed carbonyl index, ratio of two peaks; one increases with degradation, other remains constant
- Ratio is needed to normalize differences in film thickness



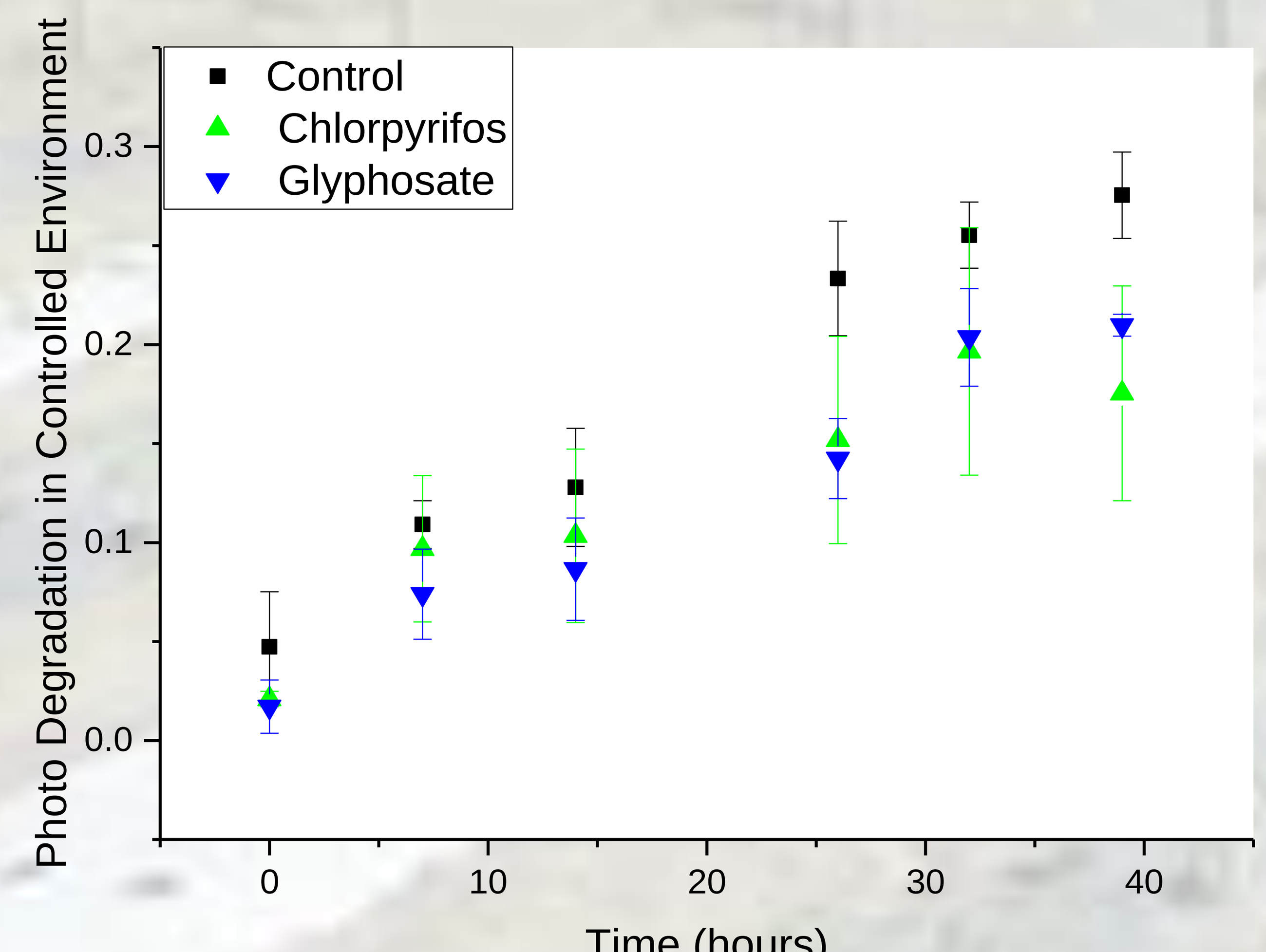


Figure 1: The carbonyl index was measured over time. Although the error is high for chlorpyrifos the control consistently had the highest degradation, chemically and physically, followed by glyphosate.

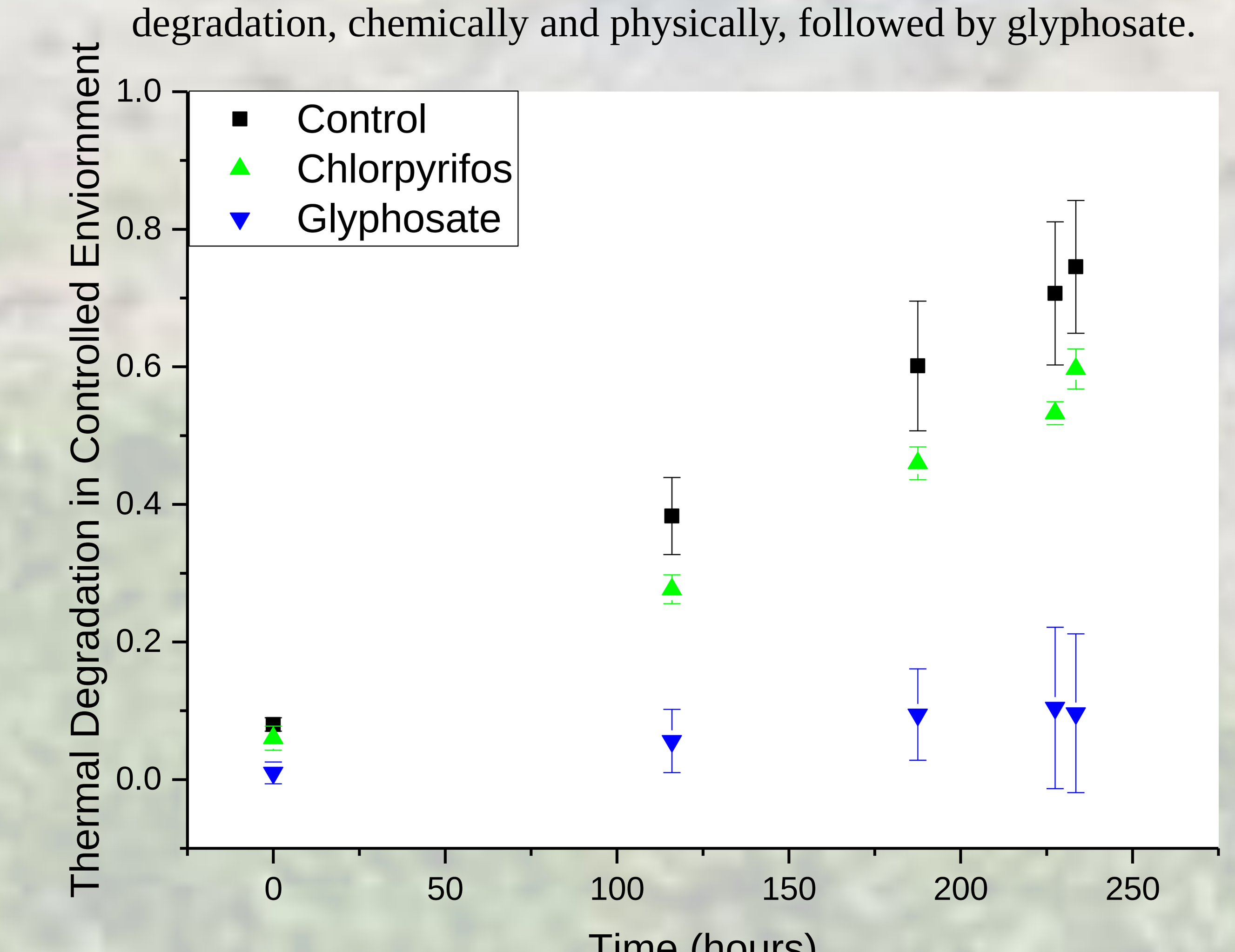


Figure 2: The carbonyl index was measured over time. The control again had the fastest degradation, followed by chlorpyrifos.

Analysis & Conclusion

Chlorpyrifos
- High UV absorbance
- High bond dissociation energy and ionization potential (unlikely to donate an electron)
- High electron affinity (likely to accept an electron)
- Likely acts as a UV screener

Glyphosate
- Low UV absorbance
- Low bond dissociation energy and ionization potential (likely to donate an electron)
- Low electron affinity (unlikely to accept an electron)
- Likely acts as an antioxidant

Application

- Pesticide application to plastic mulch delays degradation, preventing customer satisfaction
- Despite decreased need of pesticide when using plastic mulch there is no control or suggested use to compliment the lower need
- To combat the delay either less stabilizer or pesticide needs to be used
- Increased risk of runoff if pesticide is over applied
- This research is a stepping stone towards lowering the dependence on pesticides for crop development
- Agricultural methods need to accommodate climate change without a decrease in yields
- Also need to combat an increased population with decreased farmable land
- Degradable plastic mulch is an affordable option which decreases inputs, increases yields and eliminates waste that occurs with traditional mulch

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References

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3. Leopoldini, M.; Russo, N.; Toscano, M. *Food Chemistry* **2011**, *125* (2), 288–306.