Delivery systems for efficacy improvement of volatile herbicides

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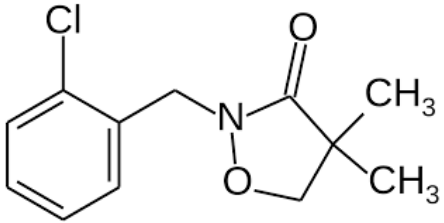
NEXT-GENERATION DELIVERY INNOVATIONS

Clomazone

- Broad-spectrum herbicide: preemergence or early post-emergence
- Moderate persistency in soil
- Half-life
  - Aerobic conditions: 47.3 days
  - Anaerobic conditions: 7.9 days
- Volatilization and transport to the environment in vapor phase
  - Detection in atmospheric samples in gaseous form (83.4 %)
  - Long-distance herbicide transport
  - Environmental contamination and injury to non-target crops
  - Human inhalation (potential adverse health effects)



(Brasil 2003, Pozo *et al*. 2009, Schummer *et al*. 2010, Tomco *et al*. 2010; Schreiber *et al.*, 2016)

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Clomazone

Commercialized products in Brazil

- Emulsifiable concentrated
  - Microencapsulated clomazone in suspension
- Microencapsulation minimizes losses by degradation
  - Current approach for capsules
  - Microplastic based systems - restrictions according to the legislation

Biodegradable capsule systems

(Memarizadeh *et al*. 2014, Nair *et al*. 2010)

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Objectives

- Develop a stable formulation containing biodegradable clomazone capsules
- Characterize the system by particle size and morphology, encapsulation efficiency, and AI loading
- Conduct stability studies
- Volatilization assessment under *in vitro* conditions
- Evaluate bioefficacy
- Assess stability under tank mix conditions

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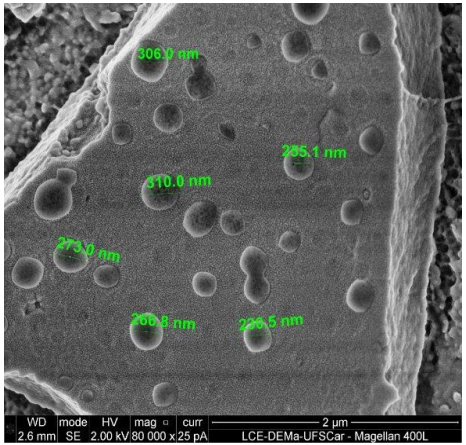
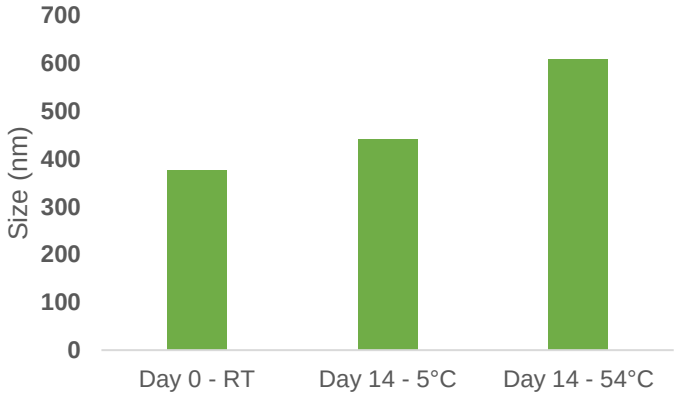
Clomazone nanoemulsion

- Nanoemulsion aspect and morphology
  - Appearance
  - Scanning electron microscopy



  - White and homogeneous nanoemulsion
  - Spherical structures with na average size of ~ 300 nm

- Stability



  - Zeta potential: - 32.9 mV
  - Encapsulation efficiency: 100.0%
  - Clomazone content: 240 g/L

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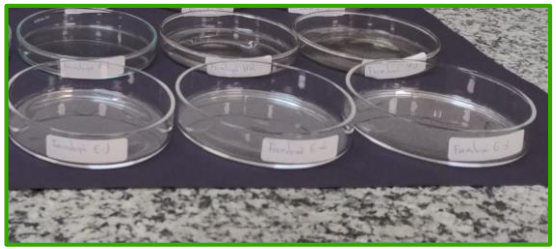
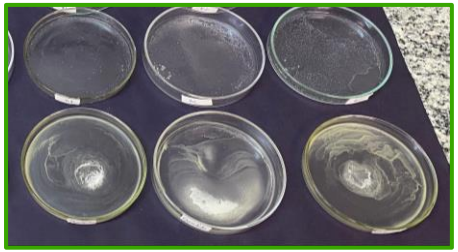
Performance assessment – Volatilization

- Assessment at t = 0h



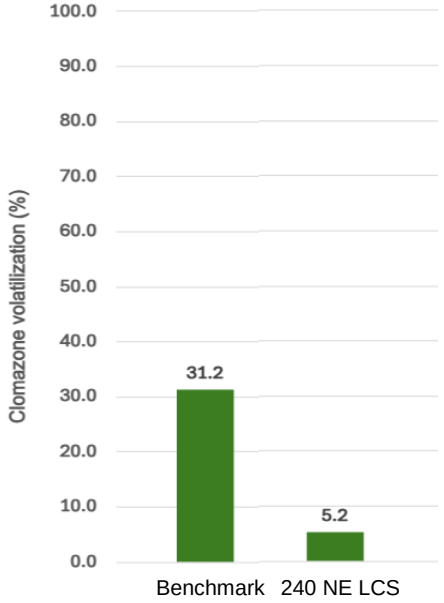
- Dilute the benchmark formulation and clomazone nanoemulsion (240 NE LCS) in water
- Add each solution to an open plate
- Allow evaporation for 72 hours

- Assessment at t = 72h



- Resuspend the contents with solvent
- Quantify the remaining clomazone using HPLC

- Clomazone volatilization after 72h



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Performance assessment – Bioefficacy

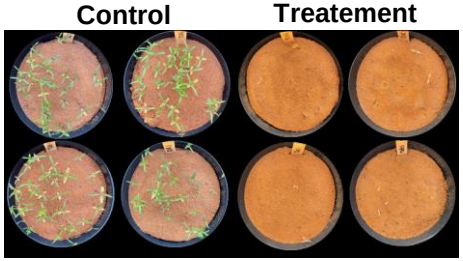
1 | Seeds preparation

- Fill pots with clay soil
- Sow *Bidens pilosa* seeds
- Apply simulated rainfall of 10 mm

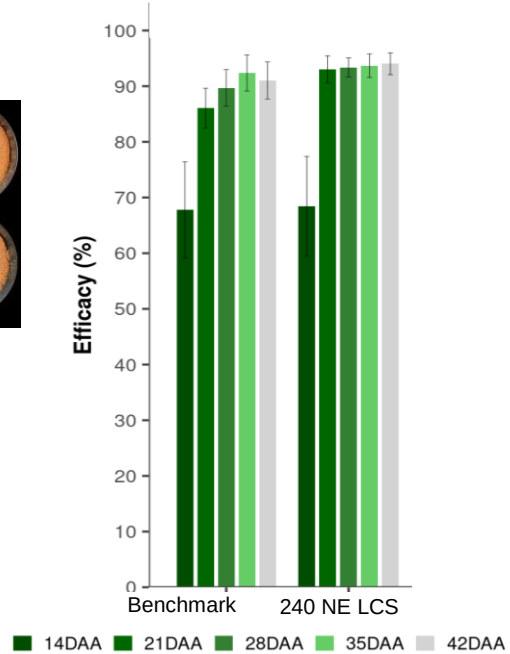
2 | Spray chamber application

- Apply treatments; control (water), benchmark, and 240 NE LCS
- Use a spraying speed of 4.0 km h^{-1}
- Apply at a rate of 200 L/ha

3 | Assessment *in planta*



- Use 8 replicates per treatment
- Assess plants assessed 5, 7, 14, 21, 28 and 42 days after application
- Calculate the % of affected plants using control as baseline



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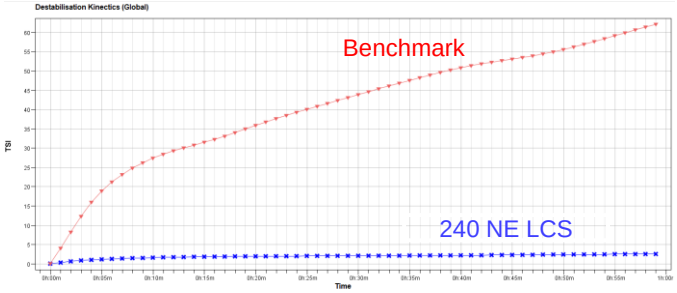
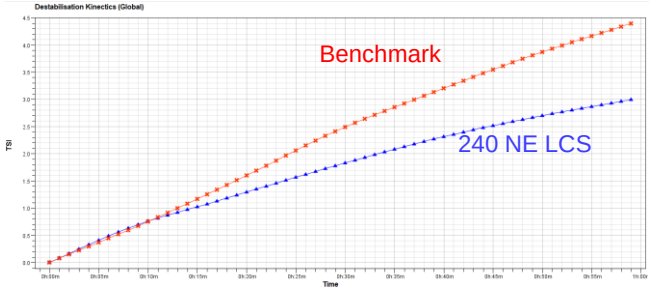
Tank mix compatibility – Turbiscan evaluation

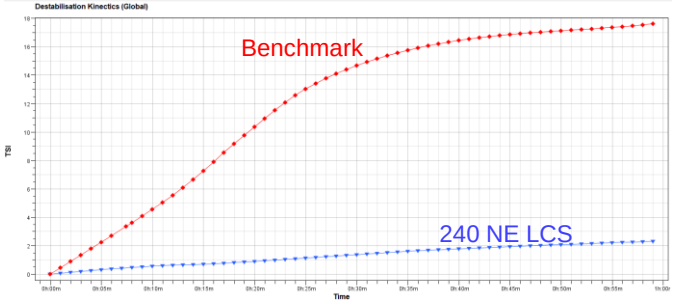
- Mix with Glyphosate



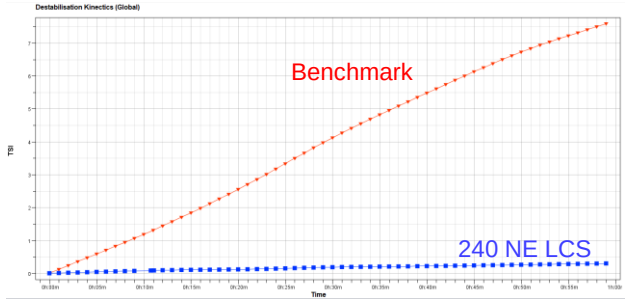
- Mix with sulfentrazone



- Mix with Metolachlor



- Mix with 2,4-D



- 240 NE LCS maintained tank mix stability for a longer period regardless of the AI combined in the mixture

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Conclusion

- A stable encapsulated formulation of clomazone was developed, with particle size in the nanoscale range
- The formulation showed high encapsulation efficiency and good stability
- Volatility studies under in vitro conditions demonstrated improved control of clomazone volatilization
- Bioefficacy evaluation indicated that the clomazone nanoemulsion was comparable to the benchmark product
- Tank mix studies showed that the clomazone nanoemulsion was more stable than the benchmark when combined with four different products

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Thank You

For your attention

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