

Ecotoxicity threshold of bentazone towards *Lactuca sativa* under Albufera lake conditions

Teresa Girona Albuixech, Monserrat García Gabaldón, Valentín Pérez Herranz and Maria Teresa Montañés Sanjuan
IEC Group, ISIRYM, Universitat Politècnica de València, Camí de Vera s/n, E-46022, València, Spain

INTRODUCTION & AIM

Bentazone (BTZ) is an herbicide detected at high and persistent levels in the **Albufera Natural Park**, a protected wetland and worthy rice-growing area in eastern Spain. The BTZ presence in reclaimed waters used in agriculture is of particular concern due to its ecotoxicity. The BTZ toxicity has been studied in aquatic organisms, but little information is available on its effects on higher plants. Besides, the Albufera lake waters contain inorganic salts, mainly **chlorides and sulfates**, which may influence the behavior, bioavailability, and toxicity of BTZ due to potential interactions.

AIMS

- Evaluate the individual ecotoxicity of BTZ using *Lactuca sativa* seeds.
- Develop a predictive statistical model to estimate toxicity thresholds based on saline concentration.

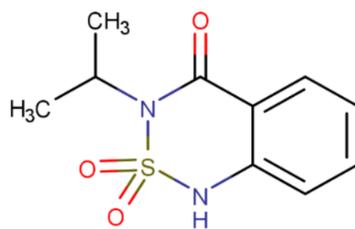


Figure 1. Structure of the BTZ molecule.

METHOD

64 concentration combinations were used to examine interactions among the three compounds. **BTZ** concentrations ranged from **0 to 900 mg L⁻¹**, while **NaCl** and **Na₂SO₄** ranged from **0 to 2.4 g L⁻¹** and from **0 to 4.2 g L⁻¹**, respectively. All solutions were prepared with ultrapure water, and pH was adjusted between 5.5 and 8.0. For each combination, 20 seeds were placed on filter paper in Petri dishes with **3 mL** of test solution, and they were incubated. All assays were performed **in triplicate**. Root elongation was measured and compared to an ultrapure water control.

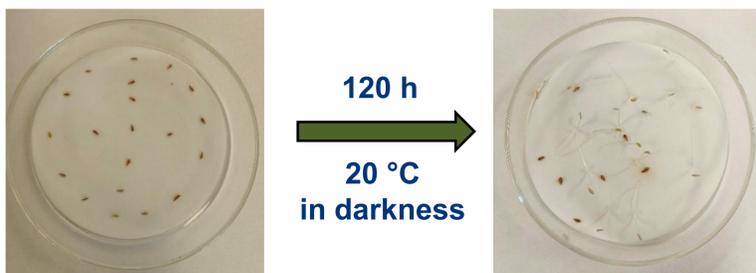


Figure 2. *Lactuca sativa* seeds before and after 5 days incubation period.

CONCLUSIONS

- BTZ** induces a non-linear phytotoxic response in *Lactuca sativa*, with hormetic stimulation at low concentrations and clear inhibition at higher doses. Its ecotoxicity, expressed as **EC₅₀ (5 days)** was **900 mg L⁻¹**.
- Salts composition is a key factor in herbicide toxicity under real environmental conditions.
- The developed predictive model reliably estimates toxicity thresholds and provides a useful tool for environmental risk assessment in saline freshwater ecosystems such as the Albufera Natural Park.

RESULTS & DISCUSSION

Hormetic response of BTZ

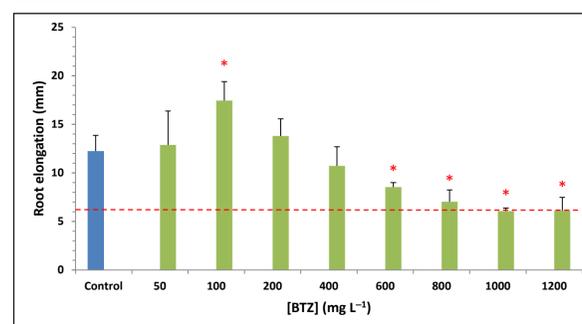


Figure 3. Average root elongation of *Lactuca sativa* seeds for different concentrations of BTZ.

Lactuca sativa root length increases with [BTZ] up to a maximum at 100 mg L⁻¹, after which higher values progressively cause seed growth inhibition. The average effective BTZ concentration for a 50% root-growth reduction from ultrapure water control (EC₅₀ (5 days)) was equal to 900 mg L⁻¹.

Statistical analysis of root-elongation decrease (DRE)

Pareto chart shows that [BTZ], [NaCl] and [Na₂SO₄] each exert a statistically significant positive effect on DRE. Both salts effects were of equal magnitude and outweighed the direct BTZ effect, indicating that water salt composition strongly modulates the BTZ toxicity.

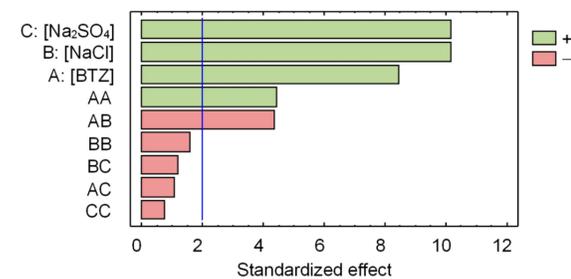


Figure 4. Pareto chart for the decrease in root elongation (DRE) of *Lactuca sativa* seeds.

Predictive mathematical model

The dose-response model predicts that raising the concentration of any individual compound reduces the concentration needed for the others to become toxic. However, when NaCl is present with BTZ < 382 mg L⁻¹, higher NaCl levels are required for toxicity, reflecting BTZ's hormetic behavior. This value of [BTZ] diminishes as [Na₂SO₄] increases.

$$[\text{Na}_2\text{SO}_4] = (30.8609 + 0.000942955 \times [\text{BTZ}] - 14.8174 \times [\text{NaCl}] - 0.0000401872 \times [\text{BTZ}]^2 + 0.0120007 \times [\text{BTZ}] \times [\text{NaCl}]) / 5.39351$$

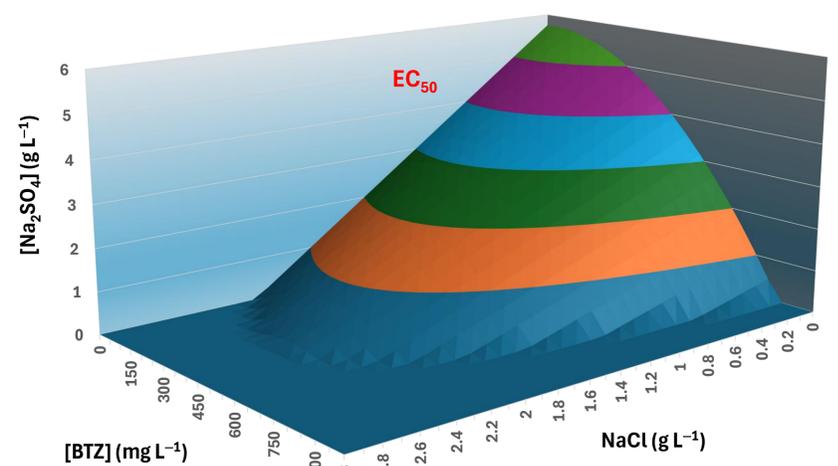


Figure 5. Three-dimensional graph of predicted EC₅₀ (5 days) values towards *Lactuca sativa* for solutions containing BTZ, NaCl and Na₂SO₄.