Investigating Herbicide Efficacy and Behavior for Controlling Eurasian Watermilfoil in Bear Lake

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PLANTS, SOILS & CLIMATE

Introduction

- Eurasian watermilfoil (*Myriophyllum spicatum* L.) (EWM) disrupts the natural ecosystem and degrades Bear Lake water quality, adversely affecting fish populations, recreational activities, water temperature, and oxygen levels.
- Florpyrauxifen-benzyl (FPB) and 2,4-D are commonly used systemic herbicides for EWM control in aquatic systems.
- Given Bear Lake's unique water chemistry, the efficacy and behavior of 2,4-D and FPB, as well as the growth of EWM, may differ compared to other water sources.

Objectives

- Examine the impact of Bear Lake's water chemistry on EWM growth in comparison to tap water.
- Investigate whether the efficacy and behavior of 2,4-D and FPB differ in Bear Lake's water compared to tap water sources.

Hypothesis

- Bear Lake and tap water will exhibit distinct patterns of EWM growth, herbicide activity and degradation.

Materials and Methods

Experiment 1: EWM Growth in Bear Lake and Tap Water

- Fifty 15cm EWM shoots were planted in greenhouse tanks filled with either Bear Lake or tap water.
- Growth was monitored over 90 days, measuring height, number of shoots per plant, and aboveground and belowground biomass.

Experiment 2: Degradation of florpyrauxifen-benzyl in Bear Lake and Tap Water

- 10 ppm of FPB was applied to ten 2 L tanks, with five tanks containing Bear Lake water and other five containing tap water (Figure 1).
- Samples were collected at time intervals of 0, 1.5, 3, 6, 12, 24, 48, and 72 hours after treatment.
- Florpyrauxifen-benzyl concentrations were analyzed using High Performance Liquid Chromatography.

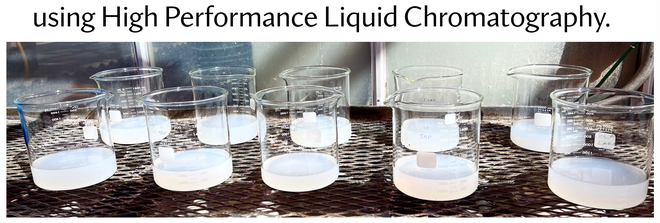

Figure 1: Ten 2 L of Bear Lake and tap water tanks treated with 10 ppm of FPB

Experiment 3: Efficacy of 2,4-D for EWM control

- 2 ppm of 2,4-D was applied to two separate tanks containing twenty-five established EWM plants for 24 hours.
- Visual evaluations were conducted weekly over 28 days.

Data Collection and Analysis

- Data (except FPB degradation) were analyzed using linear mixed-effects ANOVA in R and means were separated using Tukey's HSD (α =0.05).
- Florpyrauxifen-benzyl degradation was analyzed using a nonlinear regression analysis.

Results and Discussion

Table 1: The pH, nitrogen (N), phosphorus (P), potassium (K), sulfate (SO4-S), calcium (Ca), magnesium (Mg), and iron (Fe) concentrations of Bear Lake and tap water.

		Nutrients (mg L^{-1})						
Water source	pH	N	P	K	SO_4-S	Ca	Mg	Fe
Bear Lake	8.8	-	-	5.2	72.3	23.4	48.9	0.01
Tap water	7.7	0.2	-	0.6	7.1	50.4	19.2	-

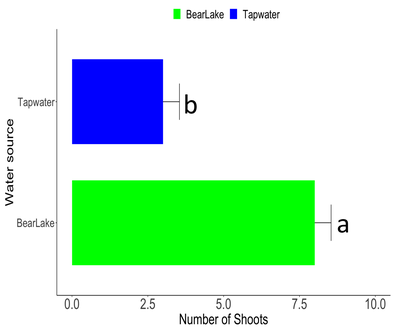

Figure 2: Number of EWM shoots per plant in Bear Lake and tap water after 90 days. Data presented are means. The same lowercase letters depict no significant difference according to Tukey's HSD (α =0.05).

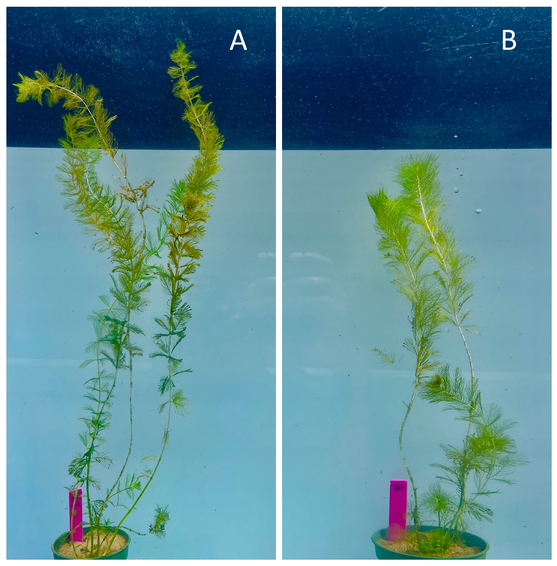

Figure 3: Pictorial evaluation of Eurasian watermilfoil growth in Bear Lake (A) and tap water (B) after 90 days.

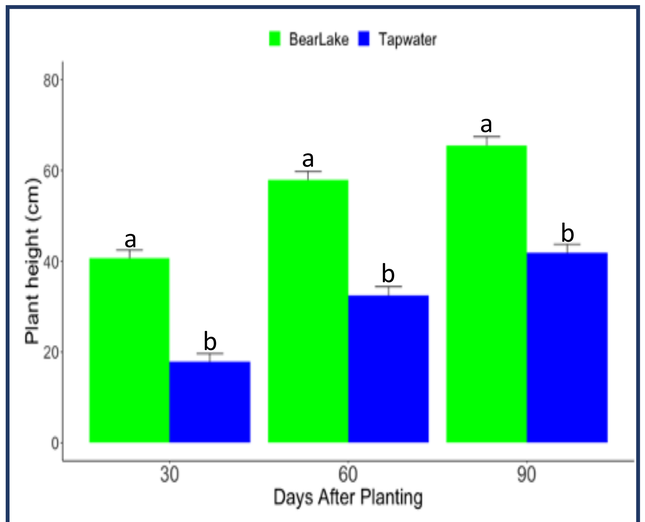

Figure 4: Plant height of Eurasian watermilfoil growth in Bear Lake water and tap water at 30, 60, and 90 days after planting. Data presented are means. The same lowercase letters depict no significant difference according to Tukey's HSD (α =0.05).

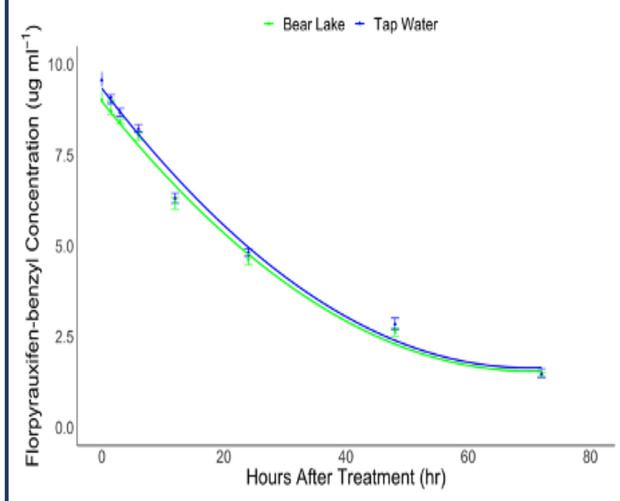

Figure 5: Florpyrauxifen-benzyl degradation in Bear Lake and tap water over 72 hours.

- EWM plants grown in Bear Lake water showed a significant increase in the number of shoots per plant after 90 days and showed a consistently significant increase in plant height at 30, 60, and 90 days after planting **(Figures 2, 3, and 4)**.
- The superior performance of EWM grown in Bear Lake peaked 90 days after planting, with the number of shoots per plant and plant height surpassing those of EWM plants grown in tap water by 2.5 times and 25 cm, respectively. High K, Mg, and SO_4-S concentrations in the Bear Lake water help move nutrients and sugars in the EWM plants while enhancing chlorophyll production.
- Although not statistically different, florpyrauxifen-benzyl degradation in Bear Lake and tap water followed similar trends, with concentrations decreasing as hours after application increased. Mean florpyrauxifen-benzyl concentrations in Bear Lake and tap water rapidly declined to 6.2 ug ml^{-1} at 12 hours after treatment (HAT), 4.7 ug ml^{-1} at 24 HAT, 2.7 ug ml^{-1} at 48 HAT, and 1.4 ug ml^{-1} at 72 HAT **(Figure 5)**.

Table 2: Aboveground and belowground biomass of untreated EWM plants grown for 90 days (A) and 2,4-D treated Eurasian watermilfoil plants (B). Data presented are means. The same lowercase letters depict no significant difference at α =0.05.

A	Untreated	
	Aboveground	Belowground
Water source	(g)	
Bear Lake	2.09a ± 0.08	1.32a ± 0.09
Tap water	0.69b ± 0.08	0.12b ± 0.09

B	Treated	
	Aboveground	Belowground
Water source	(g)	
Bear Lake	1.27a ± 0.07	0.03a ± 0.002
Tap water	0.47b ± 0.07	0.01b ± 0.002

- After a 90-day growth period, the EWM plants grown in Bear Lake water had a significantly higher aboveground and belowground dry biomass than in tap water **(Table 2A)**.
- The EWM treated with 2,4-D in Bear Lake water showed significantly higher aboveground and belowground dry biomass than those treated with 2,4-D in tap water **(Table 2B)**.
- The aboveground and belowground dry biomass of untreated EWM in Bear Lake water was 3 times and 11 times greater, respectively, than those in tap water. For the 2,4-D treated EWM, the aboveground and belowground dry biomass in Bear Lake water was 2.5 times and 3 times greater, respectively, than in tap water **(Tables 2A and 2B)**.
- Twenty-eight days after 2,4-D treatment, nine of twenty-five EWM plants in Bear Lake water exhibited new shoot growth, whereas only two of twenty-five EWM plants in tap water showed new shoot growth **(data not presented)**.

Conclusions

1. Bear Lake water's rich nutrient content has a significantly beneficial impact on EWM growth.
2. Florpyrauxifen-benzyl behavior and degradation did not differ in Bear Lake and tap water.
3. 2,4-D control of EWM in tap water (92%) was more effective than in Bear Lake water (64%).

Future Research

- Investigate the degradation of 2,4-D in Bear Lake and tap water.
- Investigate the efficacy of florpyrauxifen-benzyl in controlling established EWM.
- Repeat the experiment to ensure the validity of the results.

Funding

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