

Control of emergent invasive aquatic plants with the herbicide florpyrauxifen-benzyl (ProcellaCOR FX) in Australia

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Summary Invasive alien aquatic plants (IAAPs) cause major ecological and socio-economic impacts, yet management in Australia is constrained by the limited number of herbicides registered for aquatic use.

Florpyrauxifen-benzyl (ProcellaCOR FX, 300 g a.i. L⁻¹), registered in Australia in 2025, was evaluated in outdoor mesocosms using foliar application at 15 and 30 g a.i. ha⁻¹ and liquid injection at 25 and 50 ppb. The control efficacy of florpyrauxifen-benzyl was tested on four emergent invasive macrophytes: *Rotala rotundifolia* (Buch.-Ham. ex Roxb.) Koehne (rotala), *Myriophyllum aquaticum* (Vell.) Verdc. (parrot's feather), *Heteranthera reniformis* Ruiz & Pav. (kidney-leaved mudplantain) and *Bacopa lanigera* (Cham. & Schltdl.) Wettst. (hairy water hyssop, bacopa).

All species responded rapidly with a steady decline in plant health over time. *M. aquaticum* and *H. reniformis* were the most sensitive, with complete biomass control across all treatments. *B. lanigera* and *R. rotundifolia* were also highly susceptible, although control efficacy was more variable and slightly reduced for the lower foliar and injection rates. Biomass reductions at 42 d after treatment was 99–100% across all species with liquid injection, thus providing the most consistent control.

These results indicate that florpyrauxifen-benzyl will provide an excellent tool for managing the tested emergent species. The most appropriate application method and application rate will depend on specific site conditions, target species and economic considerations.

Keywords florpyrauxifen-benzyl, invasive alien aquatic plants, aquatic weed control.

INTRODUCTION

Invasive alien aquatic plants (IAAPs) cause significant environmental and socio-economic impacts on freshwater systems worldwide. Dense IAAP infestations can displace native vegetation, affect water quality, alter ecosystem processes, restrict recreational and commercial water use, and interfere with aquatic infrastructure (Bickel 2025). At a global scale, these impacts translate to substantial

ecological and economic costs through biodiversity loss, degradation of ecosystem services, and damage to irrigation and water-storage infrastructure (Macêdo et al. 2024). Australia faces considerable challenges managing a range of IAAPs, some of them declared Weeds of National Significance (WoNS), such as *Cabomba caroliniana* A.Gray, *Sagittaria platyphylla*, *Salvinia molesta* D.S.Mitch. and *Pontederia crassipes* Mart. (Vitelli and Petroeschovsky 2012).

There are a range of control tools for managing aquatic plants, broadly grouped into prevention, physical, biological and chemical options (Hussner et al. 2017). In Australia, the range of herbicides available for aquatic use is limited, with management programs relying on a relatively small number of long-established active ingredients (Vitelli and Petroeschovsky 2012). This restricted toolbox hinders effective aquatic weed management as the registered actives only control some species, can cause non-target impacts on native species and water resource use and limits the response to newly introduced weeds. Overreliance on single herbicide actives can also contribute to the development of herbicide resistance (Michel et al. 2004). Therefore, there is a need for new herbicides that are effective at low use rates, environmentally safe, selective in mixed plant communities and suitable for operational use in complex freshwater environments (Vitelli and Petroeschovsky 2012).

Florpyrauxifen-benzyl is a synthetic auxinic herbicide that is highly efficacious against broadleaf aquatic weeds overseas, often at comparatively low concentrations. This herbicide also has low environmental toxicity, therefore reducing acute and long-term non-target impacts (Gettys et al. 2021; Heilman 2019). The rapid absorption and translocation of florpyrauxifen-benzyl by aquatic weeds support control efficacy at low concentrations and reduces potential non-target damage to native aquatic plants (Beets et al. 2019; Haug et al. 2021). Its registration for aquatic use in Australia in 2025 provides a potentially important new option for managing species such as *M. aquaticum* and *R.*

rotundifolia for which effective control options remain limited.

The present study evaluated florypyrauxifen-benzyl control efficacy for four emergent IAAPs using foliar application and sub surface injection to assess the suitability of this herbicide for water weed management in Australia.

MATERIALS AND METHODS

Four IAAPs (*M. aquaticum*, *R. rotundifolia*, *H. reniformis* and *B. lanigera*) were cultured free-floating in 400 L outdoor mesocosms and allowed to establish sufficient surface cover before treatment. There were five treatments (7 replicates): an untreated control, foliar application at 15 and 30 g a.i. ha⁻¹ (low and high foliar), and subsurface liquid injection at 25 and 50 ppb (low and high sub). Foliar treatments were applied with a spray volume equivalent to 900 L ha⁻¹ with an adjuvant (Nemo Aquatic Surfactant; 315 g a.i. L⁻¹ cocamidopropyl betaine).

The herbicide was applied in December 2021 (summer) and any remaining biomass was harvested 42 d after treatment. Visual injury was monitored regularly during the experiment and final dry biomass was assessed by drying to constant weight at 55°C. Herbicide control efficacy was expressed as biomass reduction relative to initial biomass. Water quality varied through the experiment with a mean pH of 7.73 (range 6.79–8.82) and water temperature varied from 22.0 to 33.3°C (mean 25.7°C).

Treatment effects on final biomass were tested with ANOVA and subsequent pairwise comparisons with Tukey's HSD test. All statistical analysis was carried out in R.

RESULTS

All four target species showed a clear visual response to florypyrauxifen-benzyl. Injury symptoms developed rapidly within 24 h of treatment and included loss of turgor and stem curling, followed by a progressive decline in plant health over time. *Myriophyllum aquaticum* and *H. reniformis* were highly sensitive to the herbicide, with all treated plants dead (100% biomass control) within three weeks irrespective of application method or rate. For *Rotala rotundifolia* and *B. lanigera*, injury also increased steadily over time, although maximum damage was reached later and there were visible differences among treatments. In both species, high liquid-injection resulted in the most rapid decline in plant health, whereas the low foliar treatment was least effective.

Biomass harvest 42 days (DAT) after treatment showed high control efficacy across all tested species (Figure 1a to d). Final biomass of *M. aquaticum* and *H. reniformis* was reduced by 100% in all herbicide

treatments with a highly significant difference to control biomass (ANOVA, $p < 0.0001$; Figure 1b and c). *Bacopa lanigera* and *R. rotundifolia* were also highly susceptible, with significant treatment effects on biomass (ANOVA, $p = 0.002$ and $p < 0.0001$, respectively; Figure 1a and d). For *B. lanigera*, the high liquid-injection treatment resulted in the greatest biomass reduction (99%) and was significantly more effective than the low liquid-injection and low foliar treatments, whereas the high foliar treatment did not differ significantly (Figure 1a). *Rotala rotundifolia* was completely controlled by the high liquid-injection while the other treatments were slightly less effective, but control was only significantly different to the low foliar treatment (87%) (Figure 1d).

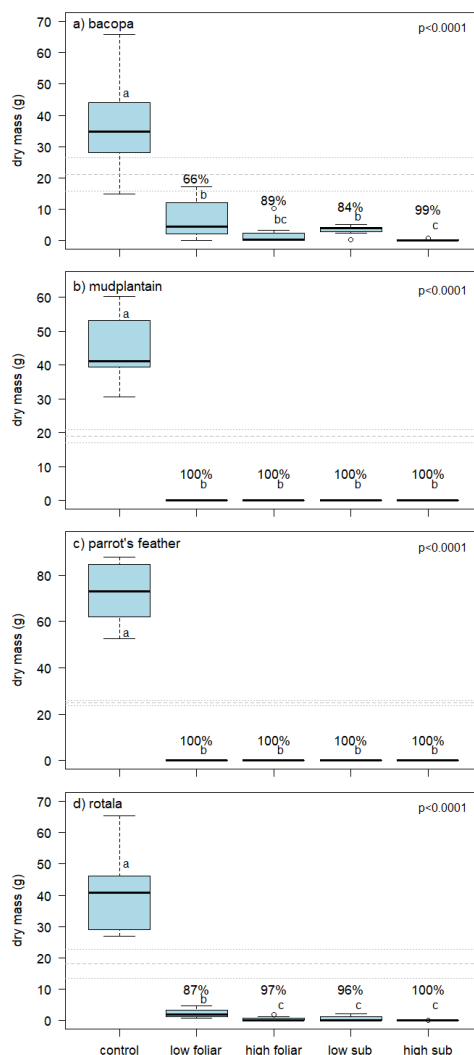


Figure 1a-d. Final dry biomass of *B. lanigera*, *H. reniformis*, *M. aquaticum* and *R. rotundifolia* after foliar and liquid-injection application of florpyrauxifen-benzyl at two rates. Lettering above boxes indicates significant difference at $p < 0.05$ (TukeyHSD); numbers above boxes show control efficacy in terms of biomass reduction; The dashed line indicates mean biomass at DAT0 ($\pm$ SD dotted lines).

DISCUSSION

Florpyrauxifen-benzyl provided high control efficacy against the four tested emergent water weeds that are new or established pests in Australia and for which there were no aquatic herbicides prior to the registration of ProcettaCOR FX. Good to excellent control was achieved for all species, irrespective of application rate or method. The visual symptoms following treatment, including loss of turgor and stem curling, was consistent with the auxinic mode of action of florpyrauxifen-benzyl (Haug et al. 2021).

Complete control of *M. aquaticum* and *H. reniformis* irrespective of application rate and method indicates the high susceptibility of these species, whereas the variable response of *B. lanigera* and *R. rotundifolia* suggest that application method and dose can influence the extent of control. The slightly higher control efficacy achieved with liquid injection for the latter two species is consistent with previous research, showing high activity of florpyrauxifen-benzyl at low concentrations (Gettys et al. 2021; Heilman 2019). Hence, liquid injection might be more suitable in sites that are difficult to spray with a foliar application or contain very dense emergent stands with high weed biomass.

These findings have practical importance for aquatic weed management in Australia, where the number of herbicides registered for freshwater use remains limited (Vitelli and Petroeschovsky 2012). The strong control efficacy observed in this study demonstrates that florpyrauxifen-benzyl will be an excellent tool for invasive aquatic management and will improve the ability to respond to the growing threat of invasive weeds.

The choice of application rate and application technique should be guided by specific site conditions, the target species, access, water movement, presence of native macrophytes and cost. The high sensitivity of the four species will allow a reduction of overall herbicide load applied to water bodies which will help reduce non-target impacts and reduce management costs.

Future research should examine control efficacy of florpyrauxifen-benzyl across a broader range of Australian aquatic weeds and determine non-target effects on native macrophytes. Additionally, field

trials are required to examine how the new herbicide will perform under real-world operational conditions, to refine best-practice use of this herbicide and also how it can be integrated with other control tools.

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REFERENCES

- Beets, J., Heilman, M. and Netherland, M.D. (2019). Large-scale mesocosm evaluation of florpyrauxifen-benzyl, a novel arylpicolinate herbicide, on Eurasian and hybrid watermilfoil and seven native submersed plants. *Journal of Aquatic Plant Management* 57, 49–55.
- Bickel, T. O. (2025). Aquatic Plant Management. In B. S. Chauhan & G. Mahajan (Eds.), *Recent Advances in Weed Science* (pp. 189–215). Cham: Springer Nature Switzerland.
- Haug, E.J., Ahmed, K.A., Gannon, T.W. and Richardson, R.J. (2021). Absorption and translocation of florpyrauxifen-benzyl in ten aquatic plant species. *Weed Science* 69, 624–630.
- Gettys, L.A., Thayer, K.L., Heilman, M.A. and Van Goethem, E.M. (2021). Effect of florpyrauxifen-benzyl concentration–exposure time on hygrophila and rotala. *Journal of Aquatic Plant Management* 59, 79–84.
- Heilman, M. (2019). Selective control of invasive watermilfoils with ProcettaCOR aquatic herbicide and response of native aquatic plants. Technical report, Lake George Park Commission, New York, USA.
- Hussner, A., Stiers, I., Verhofstad, M. J. J. M., Bakker, E. S., Grutters, B. M. C., Haury, J., van Valkenburg, J. L. C. H., Brundu, G., Newman, J., Clayton, J. S., Anderson, L. W. J., & Hofstra, D. (2017). Management and control methods of invasive alien freshwater aquatic plants: A review. *Aquatic Botany*, 136, 112–137.
- Michel, A., Arias, R.S., Scheffler, B.E., Duke, S.O., Netherland, M.D. and Dayan, F.E. (2004). Somatic mutation-mediated evolution of herbicide resistance in the invasive plant hydrilla (*Hydrilla verticillata*). *Molecular Ecology* 13, 3229–3237.
- Macêdo, R.L., Haubrock, P.J., Klippel, G., Fernández, R.D., Leroy, B., Angulo, E., Carneiro, L., Musseau, C.L., Rocha, O. and Cuthbert, R.N. (2024). The economic cost of invasive aquatic plants: a global perspective on

ecology and management gaps. *Science of the Total Environment* 908, 168217.

Vitelli, J. and Petroeschevsky, A. (2012). Expanding the list of aquatic herbicides for use in Australia – the conundrum of do we stop, welcome or remain neutral on its expansion? In: *Proceedings*

of the 18th Australasian Weeds Conference, Melbourne, Australia, pp. 277–280.