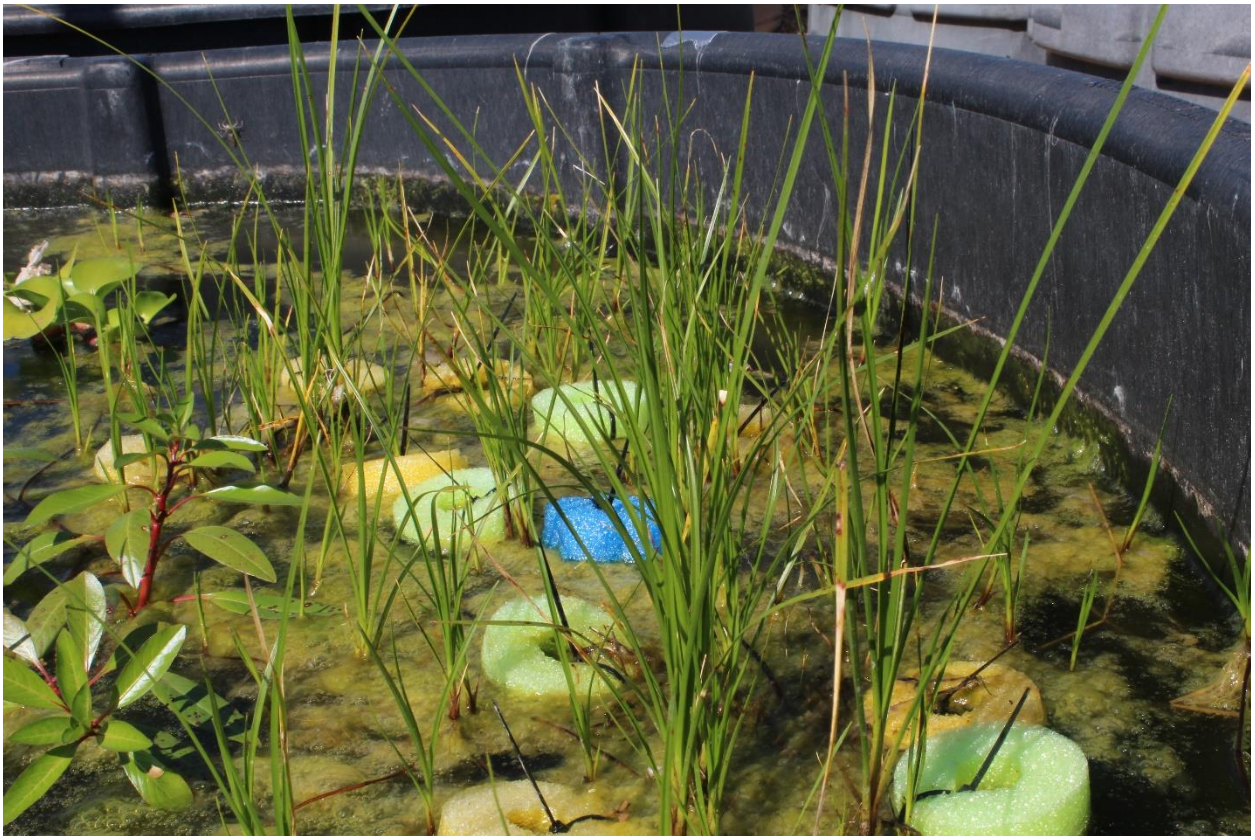
Assessment of Procellacor Combination Treatments on Invasive Aquatic Plants



A report to the Florida Fish and Wildlife Conservation Commission

Gray Turnage, PhD

Geosystems Research Institute, Mississippi State University, Mississippi State, MS 39762-9627

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Gray Turnage, PhD

Geosystems Research Institute, Mississippi State University, Box 9627, Mississippi State, MS 39762-9627, 662-325-752, gturnage@gri.msstate.edu

BACKGROUND

Florpyrauxifen-benzyl (Procellacor) is a new herbicide in the auxinic class of herbicides (i.e., similar to 2, 4-D and triclopyr) that is registered for use in aquatic environments. It has shown good to excellent activity on invasive aquatic plant species. however, effects of procellacor on many free-floating (water hyacinth [*Eichhornia crassipes*], water lettuce [*Pistia stratiotes*], Cuban bulrush [*Oxycaryum cubense*]) and rooted (Primrose [*Ludwigia grandiflora*]) invasive plant species are still understudied. The purpose of this project was to:

- Assess mid-season florpyrauxifen-benzyl treatments against invasive and native plant species to determine short (8 WAT) and long term control (52 WAT)
- Assess late-season florpyrauxifen-benzyl treatments against invasive and native plant species to determine short (8 WAT) and long term control (52 WAT)

MATERIALS AND METHODS

This trial was initiated in August of 2020. Plants were grown in 1135 L (300 gal) mesocosms filled to a depth of 48 cm (19 in) with pond water. Water primrose (*Ludwigia* *grandiflora*), water hyacinth (*Eichhornia crassipes*), water lettuce (*Pistia stratiotes*), and Cuban bulrush (*Oxycaryum cubense*) were the target species. Seven sampling units of each species were placed in each mesocosm. Primrose was established by placing two 30.5 cm (1 ft) shoots in 3.8 L (1 gal) pots filled with sand and amended with a slow release fertilizer (2 g L^{-1} sediment) to stimulate plant growth. Seven water hyacinth and water lettuce rosettes were floated in circular foam quadrats in each mesocosm to prevent competition with other species. Two Cuban bulrush ramets were placed on floating substrate (bird netting stretched over a square PVC frame). Plants were allowed to establish for 1.5 months prior to administering foliar applications of herbicides. One sampling unit of each species was harvested per mesocosm prior to herbicide application to establish a baseline of plant growth. Water primrose was separated into above and below ground biomass, placed in labeled paper bags, and dried at 70C for 5 days. Water hyacinth and water lettuce were harvested and placed in separate labeled paper bags, and also dried. Cuban bulrush was separated into emergent and submersed biomass, placed in paper bags, and also dried. After drying, biomass weight was measured and recorded for each sample.

After pre-treatment harvest, herbicide treatments were administered as a foliar spray and included 1% v:v MSO surfactant (Table 1). At 8 and 52 weeks after treatment (WAT), half the remaining plants in each mesocosm were harvested and processed in the same manner as pre-treatment specimens. Water hyacinth and water lettuce reference plants did not recover from winter senescence, so samples for these species were not collected 52 WAT.

A mixed model analysis of variance (ANOVA) was used to detect differences in treatments. If differences were detected, a Fishers Exact test was used to separate treatment means. All statistical analyses were conducted at the alpha = 0.05 significance level.

RESULTS AND DISCUSSION

Aboveground biomass of water primrose was reduced 70 to 100% ($p<0.0001$) by all treatments 8 WAT compared to reference plants; however, plants in all treatments had recovered by 52 WAT (Figure 1). Belowground primrose biomass was not reduced by any treatment at 8 or 52 WAT (Figure 1). The lack of long term reduction of water primrose suggests the florpyrauxifen-benzyl should not be utilized as part of a primrose management plan (Figure 1).

Water hyacinth was reduced 84 to 100% ($p=0.0002$) by all treatments except high doses of florpyrauxifen-benzyl alone (Figure 2). Water lettuce ($p<0.0001$) was reduced 98 to 100% by all treatments containing flumioxazin and by high rates of florpyrauxifen-benzyl combined with high rates of penoxsulam (Figure 2). Florpyrauxifen-benzyl needs further screening against water hyacinth as it reduced biomass alone and in combination with penoxsulam and flumioxazin. The lack of water lettuce biomass reduction for plants treated with florpyrauxifen-benzyl suggests this herbicide should not be utilized as a stand-alone control mechanism but rather tank mixed with other herbicides when targeting this species.

Emergent Cuban bulrush was reduced 98 to 100% ($p=0.0001$) 8 WAT by all treatments containing flumioxazin and by high doses of florpyrauxifen-benzyl mixed with the high rate of penoxsulam; none of the other treatments reduced emergent Cuban bulrush when compared to reference plants (Figure 3). Emergent Cuban bulrush was reduced 96 to 100% ($p<0.0001$) 52 WAT by all treatments when compared to reference plants (Figure 3). None of the herbicide treatments reduced submersed Cuban bulrush biomass 8 WAT compared to reference plants (Figure 3). However, all treatments had reduced submersed Cuban bulrush biomass 91 to 100% ($p<0.0001$) 52 WAT when compared to reference plants (Figure 3). Long term control of Cuban bulrush by florpyrauxifen-benzyl suggests this herbicide may provide a stand-alone control option for nuisance bulrush colonies; however, this needs to be validated with field trials prior to implementation in operational control strategies.

CONCLUSIONS

- Procellacor alone and in combination reduced nuisance growth of Cuban bulrush, water hyacinth, and aboveground water primrose but not water lettuce.
- All treatments containing flumioxazin reduced target plant biomass.
- These results should be validated on field populations of each species prior to recommendation as operational protocols.

LITERATURE CITED

R Core Team. 2021. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org/. Date Accessed: 12-15-2021.

TABLES AND FIGURES

Table 1. Herbicide treatments and mixtures tested for the control of water primrose, water hyacinth, water lettuce, and Cuban bulrush; rates represent the maximum and half-maximum label use rates.

TREATMENT	Rate 1 (lb. ai/ac)	Rate 2 (lb. ai/ac)	MSO (v:v)
Reference	-	-	-
Florpyrauxifen-benzyl	0.026	-	1%
Florpyrauxifen-benzyl	0.052	-	1%
Florpyrauxifen-benzyl + Penoxsulam	0.026	0.044	1%
Florpyrauxifen-benzyl + Penoxsulam	0.052	0.044	1%
Florpyrauxifen-benzyl + Penoxsulam	0.026	0.088	1%
Florpyrauxifen-benzyl + Penoxsulam	0.052	0.088	1%
Florpyrauxifen-benzyl + Flumioxazin	0.026	1.85	1%
Florpyrauxifen-benzyl + Flumioxazin	0.052	1.85	1%
Florpyrauxifen-benzyl + Flumioxazin	0.026	3.70	1%
Florpyrauxifen-benzyl + Flumioxazin	0.052	3.70	1%

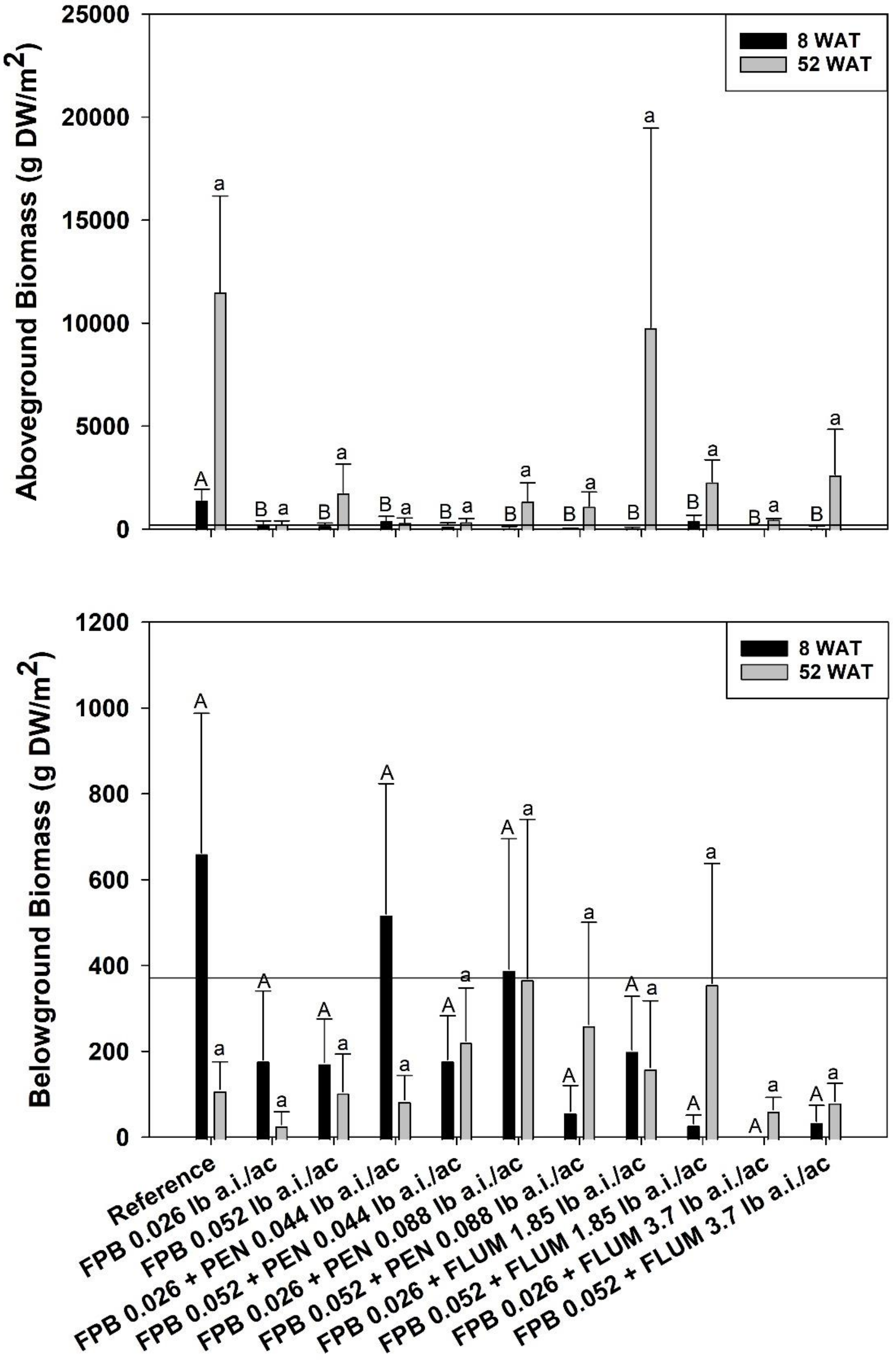

Figure X. Water primrose aboveground (top panel) and belowground biomass (bottom panel) harvested at 8 and 52 weeks after treatment (WAT); data from each harvest event was analyzed separately; error bars are one standard error of the mean; bars sharing the same letter are not different at the alpha = 0.05 significance level (n=6); solid lines are pre-treatment biomass; along the x-axis, 'FPB' is florpyrauxifen-benzyl, 'PEN' is penoxsulam, and 'FLUM' is flumioxazin.

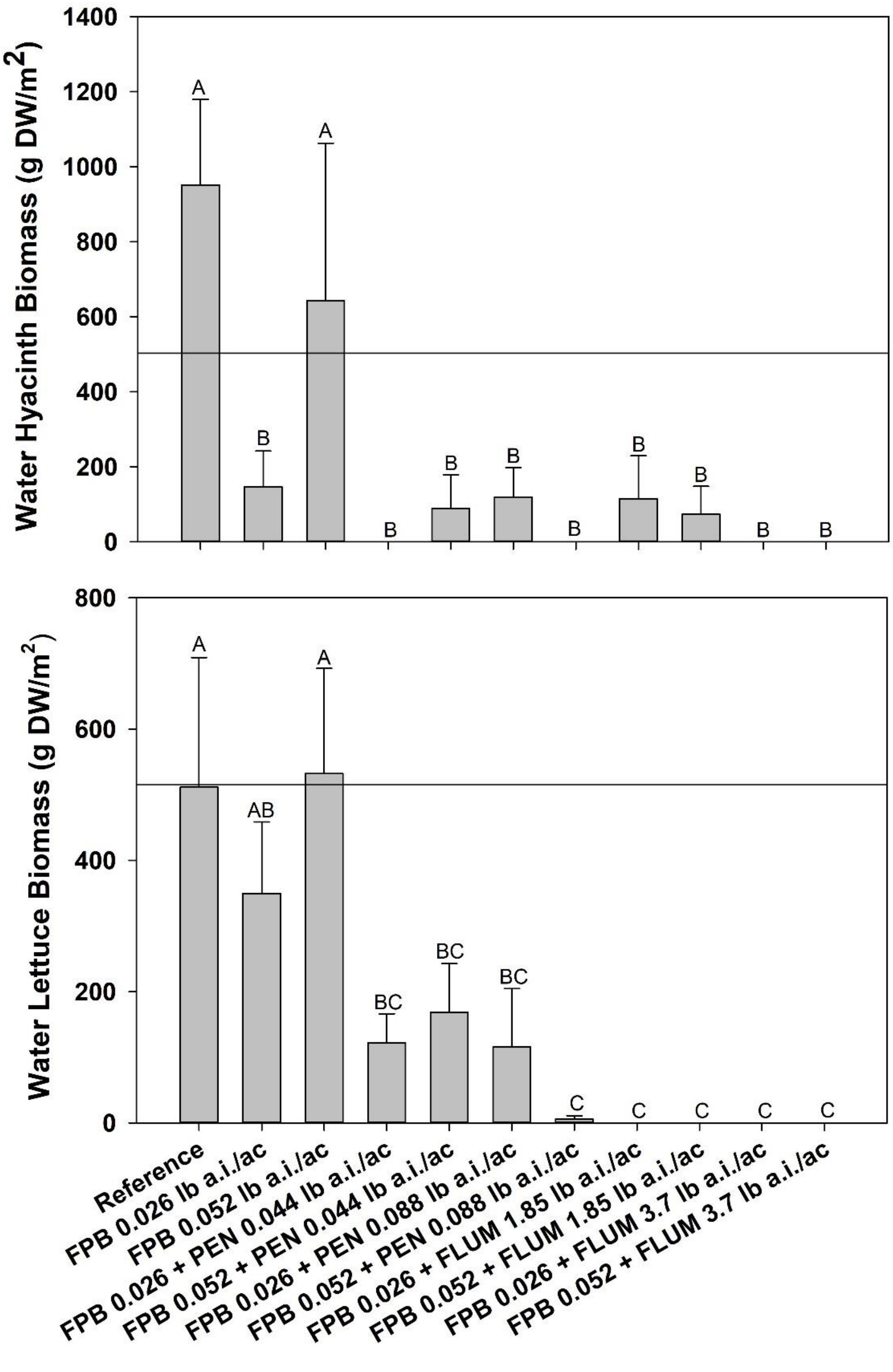

Figure Y. Water hyacinth (top panel) and water lettuce biomass (bottom panel) harvested at 8 weeks after treatment (WAT); error bars are one standard error of the mean; bars sharing the same letter are not different at the alpha = 0.05 significance level (n=6); solid lines are pre-treatment biomass; along the x-axis, ‘FPB’ is florpyrauxifen-benzyl, ‘PEN’ is penoxsulam, and ‘FLUM’ is flumioxazin.

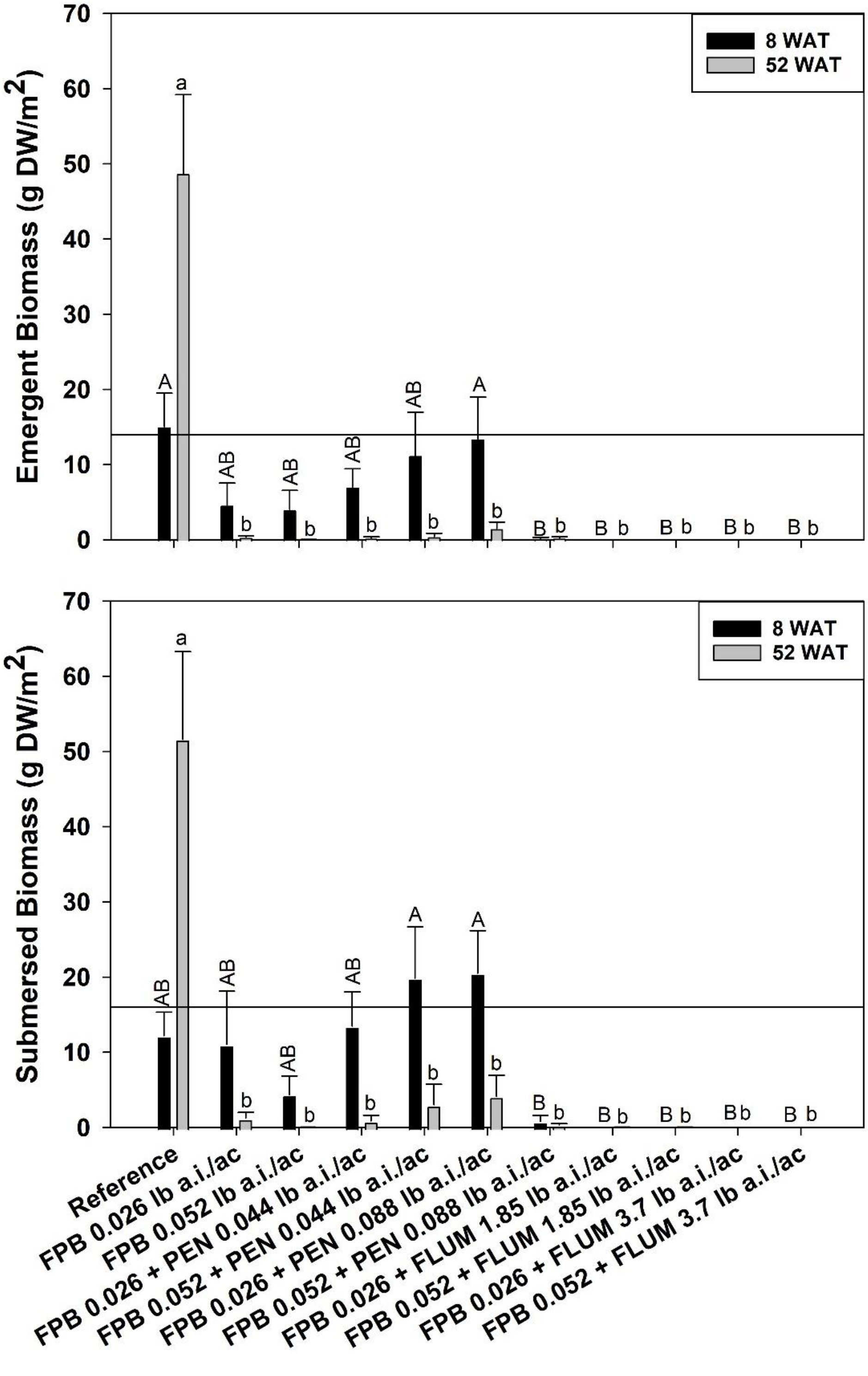

Figure Z. Emergent (top panel) and submersed (bottom panel) Cuban bulrush biomass harvested at 8 and 52 weeks after treatment (WAT); data from each harvest event was analyzed separately; error bars are one standard error of the mean; bars sharing the same letter are not different at the alpha = 0.05 significance level (n=6); solid lines are pre-treatment biomass; along the x-axis, 'FPB' is florpyrauxifen-benzyl, 'PEN' is penoxsulam, and 'FLUM' is flumioxazin.