Development of a BMP Strategy for Cuban Bulrush – Year 2 Interim Report

A report to the Florida Fish and Wildlife Conservation Commission

Gray Turnage

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

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

BACKGROUND

This project is focused on producing a handbook outlining Best Management Practices (BMP) strategies for Cuban bulrush (*Oxycaryum cubense*) management. Most of this information can be compiled from existing literature. However, some critical information needed to be generated in order to deliver a complete handbook. Year 1 of this project focused on conducting two mesocosm trials to generate the needed data: 1) rate reductions of existing foliar herbicide treatments and 2) concentration exposure times of submersed herbicide injections. Year 2 focused finalizing the 2 objectives above, reviewing literature, and compiling the final BMP manual. Year 3 will focus on dissemination of the final BMP manual to stakeholders through digital files (i.e., PDF's of the BMP manual) and presentations at stakeholder meetings (i.e., FWC research symposium).

MATERIALS AND METHODS

Trial 1: Rate Reduction – This trial was conducted in 378 L (100 gal) outdoor mesocosms filled with pond water in the late-summer of 2020. Cuban bulrush was established by placing two ramets on netting stretched across 0.1 m^2 floating PVC frames. Eight frames were placed in each mesocosm. Treatments consisted of foliar applications of a non-treated reference, 2,4-D, triclopyr, and diquat; each herbicide was tested at the maximum label rate, ½ the maximum rate, and ¼ of the maximum label rate and contained a 0.5% v:v non-ionic surfactant. Each treatment was replicated four times. Four additional mesocosms were established so the pre-treatment specimens could be harvested to establish a baseline of plant growth; there were a total of 44 mesocosms.

Prior to herbicide applications, plants were harvested from pre-treatment mesocosms, separated into emergent and submersed biomass, placed in labeled paper bags, and dried in a forced air oven for 3 days at 70C. After drying, biomass weight was measured and recorded.

Herbicide treatments were administered with a CO2 pressurized backpack sprayer at a rate of 935.4 L ha^{-1} (100 gal ac^{-1}) and a pressure of 30 kPa (0.29 atm). At 8 and 52 weeks after treatment (WAT), Cuban bulrush rhizomes and shoots were clipped at the perimeter of half the frames in each mesocosm and those frames were harvested in the same manner as pre-treatment specimens.

A one way analysis of variance was conducted to determine if there were differences in biomass among treatments. If differences existed, a Fishers Exact test was conducted to further separate treatment means. All statistical analysis was conducted at the alpha = 0.05 significance level (R Core Team).

Trial 2: Concentration Exposure Time – This trial was initiated at the same time as Trial 1. Cuban bulrush, yellow pondlily (*Nuphar lutea*), and American lotus (*Nelumbo lutea*) were established in outdoor mesocosms to determine if the herbicides tested could selectively reduce Cuban bulrush. American lotus seeds were collected from field populations, scarified with an electric belt sander to rupture the seed coat, and floated in water for 3 days to stimulate sprouting. Once sprouted, two lotus seedlings were placed in a 3.8 L (1.1 gal) pot filled with sand and amended with slow release fertilizer (2 g L^{-1} sediment) to stimulate plant growth. Pondlily rhizome meristems were collected from field populations and transplanted into 13.2 L (3.48 gal) trays filled with the same sand and fertilizer mixture as lotus pots. Cuban bulrush was established by placing two ramets on floating quadrats of netting stretched between circular foam floats. There were 4 pots of lotus, one tray of pondlily, and four quadrats of Cuban bulrush established in each mesocosm. Plants were allowed to grow for 1.5 months prior to herbicide applications.

Herbicides selected for this work were the auxinic herbicides 2,4-D and florpyrauxifen-benzyl (FPB). 2,4-D and FPB were applied at multiple rates and plants were exposed to the herbicides for varying lengths of time (Table 2) to determine if an herbicide exposure time relationship existed that would describe the needed herbicide rate and contact time for Cuban bulrush reduction. Treatments consisted of a non-treated reference, nine 2,4-D rate x exposure-time treatments, and nine FPB rate x exposure-time treatments (Table 2); treatments were replicated 4 times. An additional 4 mesocosms were established so the pre-treatment specimens could be harvested to establish a baseline of plant growth. In total, there were 80 mesocosms established.

Pre-treatment harvest consisted of collecting all aboveground biomass of rooted plants (lotus and pondlily) or harvesting and separating emergent and submersed biomass (Cuban bulrush). Biomass was placed in labeled paper bags and dried in a forced air oven at 70C for 4 days. After drying, biomass weights were measured and recorded.

Herbicides were administered as submersed injections. Herbicide treated water was drained and mesocosms refilled with herbicide free water for each exposure time scenario (Table 2). At 10 and 52 WAT, half of the American lotus and Cuban bulrush plants were harvested and processed in the same manner as pre-treatment specimens. Due to high levels of mortality during the transplant process, there were only enough pondlily plants for one harvest event, thus plants were only harvested and processed at 52 WAT in order to determine long term effects of herbicides on this species.

A two way analysis of variance using rate and exposure time as main effects was conducted to determine if treatments were different. If differences existed in a main effect, a Fishers Exact test was conducted to separate treatment means. All statistical tests were conducted at the alpha = 0.05 significance level (R Core Team 2021).

RESULTS AND DISCUSSION

Trial 1 – Cuban bulrush emergent biomass was reduced 100% by all herbicide treatments when compared to reference plants 8 WAT ($p=0.0001$) and reduced 72 to 99% by 52 WAT ($p<0.0001$; Figure 1). Submersed Cuban bulrush biomass was reduced 64 to 100% by all herbicide treatments 8 WAT and reduced 70 to 100% 52 WAT ($p<0.0001$) compared to reference plants (Figure 1).

This suggests that low rates (1/4 maximum label rate) of 2,4-D, triclopyr, or diquat applied to Cuban bulrush foliage may provide biomass suppression for up to a year; however, this needs to be validated in field sites prior to operational use.

Trial 2 – American lotus was reduced 100% by all 2,4-D ($p=0.0286$) and FPB ($p=0.02867$) rates at 10 WAT compared to reference plants (Figures 2 and 3); however, exposure time of 2,4-D and FPB did not affect biomass when compared to reference plants ($p>0.05$ for both). Neither 2,4-D or FPB rates or exposure time reduced lotus biomass 52 WAT compared to reference plants ($p>0.05$ for all). Yellow pondlily aboveground biomass was not affected by any herbicide rate exposure time combination 52 WAT compared to reference plants ($p>0.05$ for all). Cuban bulrush emergent and submersed biomass were not reduced by any herbicide exposure time scenario 10 WAT compared to reference plants ($p>0.05$ for all). At 52 WAT, Cuban bulrush biomass was not affected by any FPB rate exposure time scenario ($p>0.05$ for all) compared to references. However, all 2,4-D rates reduced emergent Cuban bulrush 89 to 97% ($p=0.0337$) and 2.0 ppm reduced submersed biomass 96% ($p=0.0297$) compared to reference plants 52 WAT (Figure 4). Submersed Cuban bulrush biomass of other 2,4-D rates were not different from reference plants 52 WAT (Figure 4). Exposure time did not affect Cuban bulrush biomass treated with 2,4-D 52 WAT ($p>0.05$).

These data suggest that 2,4-D applied as a submersed injection may suppress Cuban bulrush biomass; however, field testing is needed for validation and short term injury may occur on American lotus in sites co-inhabited by both species. Cuban bulrush was not affected by submersed injections of FPB.

CONCLUSIONS

- Results of Trial 1 suggest that resource managers can reduce herbicide rates of 2,4-D, triclopyr, or diquat to ¼ of the maximum label rate and still attain control of Cuban bulrush 52 WAT.
- Results of Trial 2 suggest that Cuban bulrush is sensitive to submersed injections of 2,4-D and but not FPB.

Update - Final Report

- Research Trials (above) have been completed so that compilation of the BMP manual can progress to the final stages.
- Literature review is progressing and will be completed in Year 2.
- Compilation of the BMP manual is progressing and will be completed in Year 2.

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: 12-19-2021.

TABLES AND FIGURES

Table 1. Foliar herbicide treatments examined for the short and long term control of Cuban bulrush; all treatments included 0.5%v:v NIS.

TREATMENT	RATE (lb. a.i./ac)
Reference	-
2,4-D	3.80
2,4-D	1.90
2,4-D	0.95
Triclopyr	5.99
Triclopyr	2.99
Triclopyr	1.49
Diquat	3.99
Diquat	1.99
Diquat	0.99

Table 2. Submersed herbicide treatments (and exposure times) examined for the short and long term control of Cuban bulrush, American lotus, and yellow pond-lily.

HERBICIDE	**CONCENTRATION** (ppm)	**EXPOSURE TIME** (Hrs.)
Reference	NA	NA
2,4-D	1.0	24, 72, 336 (2 wks.)
2,4-D	2.0	24, 72, 336 (2 wks.)
2,4-D	4.0	24, 72, 336 (2 wks.)
Florpyrauxifen-benzyl	0.012	12, 24, 72
Florpyrauxifen-benzyl	0.025	12, 24, 72
Florpyrauxifen-benzyl	0.050	12, 24, 72

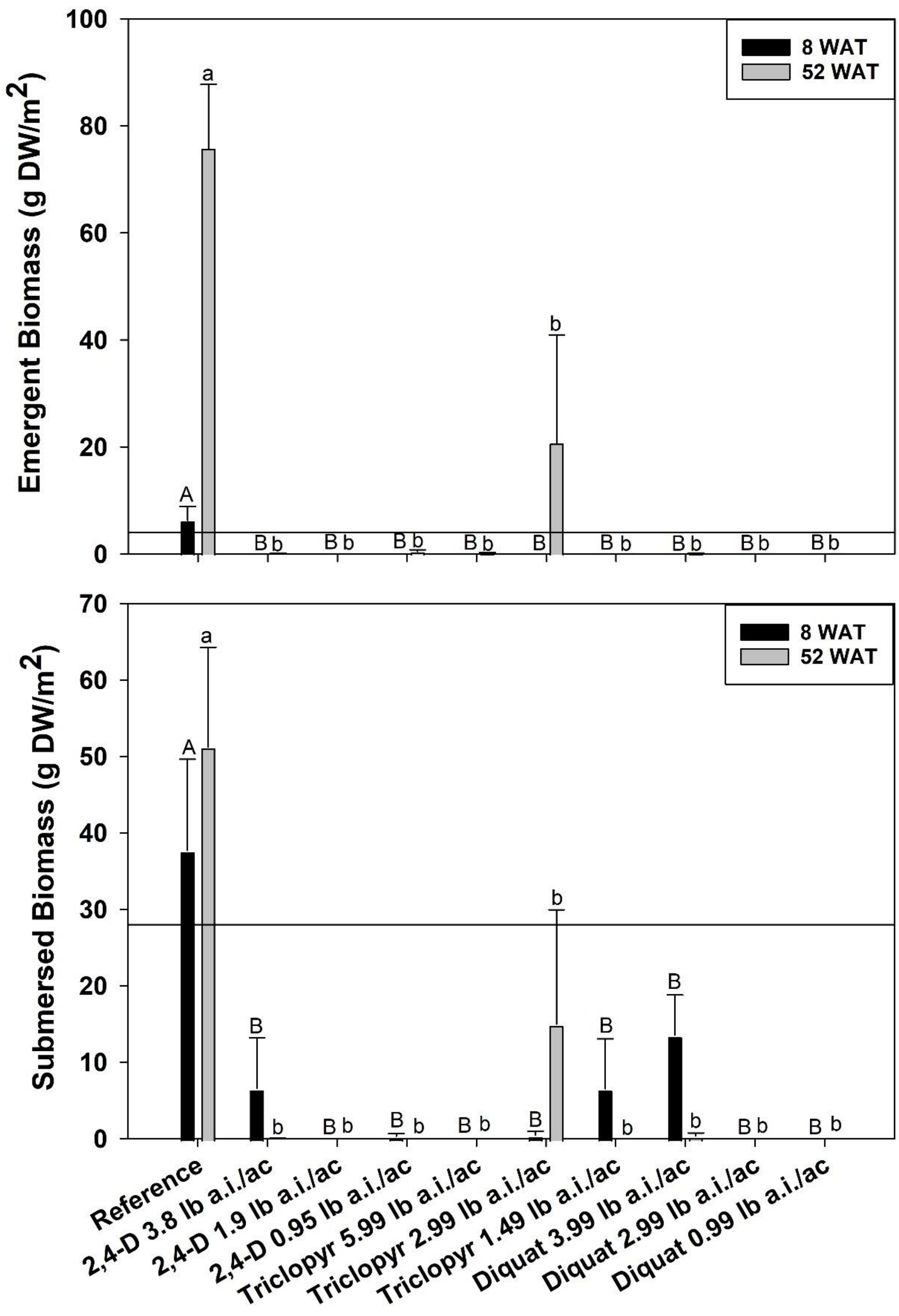

Figure 1. Cuban bulrush emergent (top panel) and submersed (bottom panel) biomass at 8 and 52 weeks after treatment (WAT); data for each date was analyzed separately; error bars are one standard error of the mean; bars sharing the same letter are not different at the alpha = 0.05 significance level (n=4); solid lines are pre-treatment means.

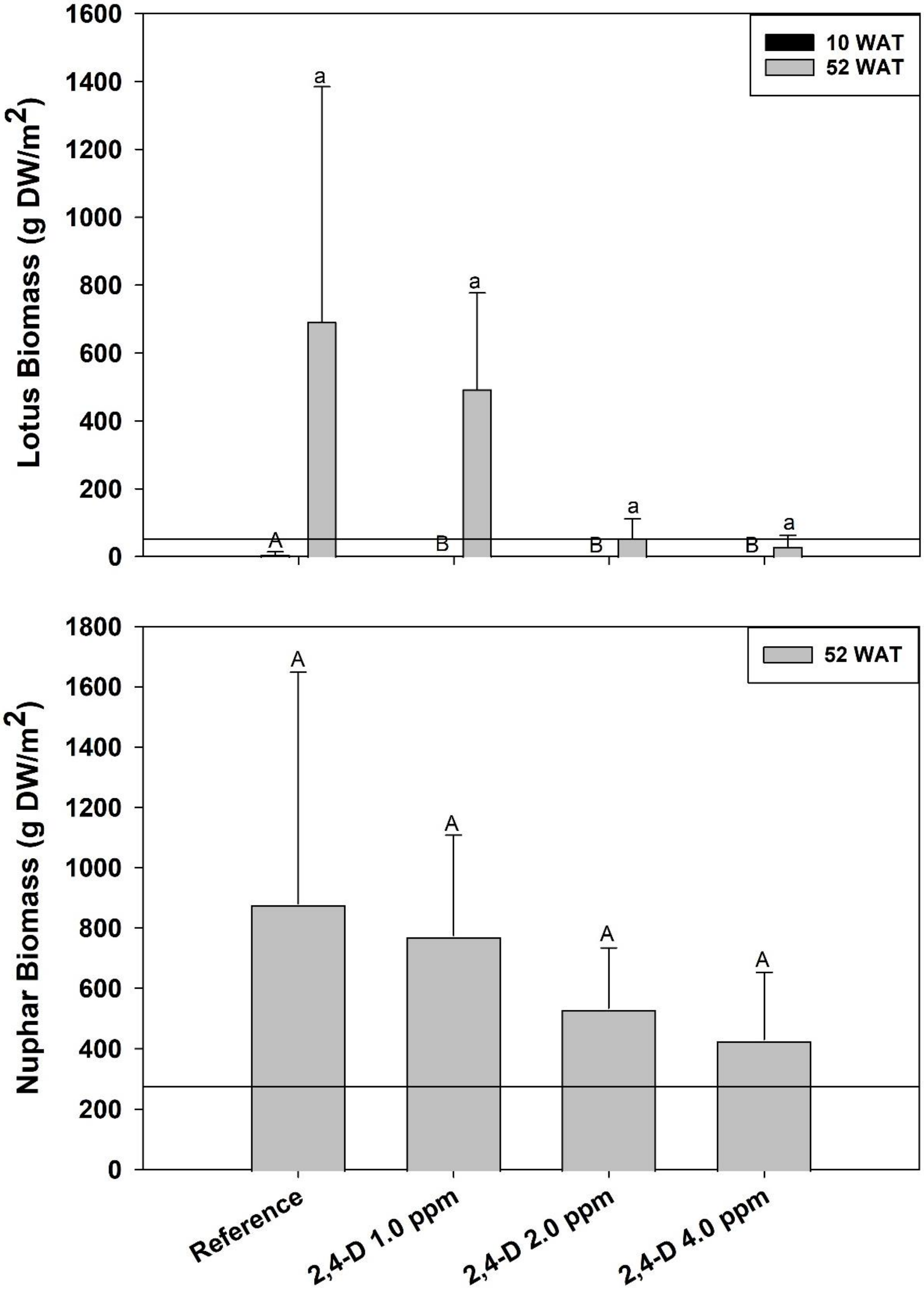

Figure 2. Aboveground biomass of American lotus (top panel) and yellow pondlily (bottom panel) treated with 2,4-D; American lotus was harvested at 10 and 52 weeks after treatment (WAT) while pondlily was only harvested at 52 WAT; separate analyses were conducted for each data collection event; error bars are one standard error of the mean; bars sharing a letter are not different at the alpha = 0.05 significance level (reference n=4 and treatment n=12); solid lines are pre-treatment means.

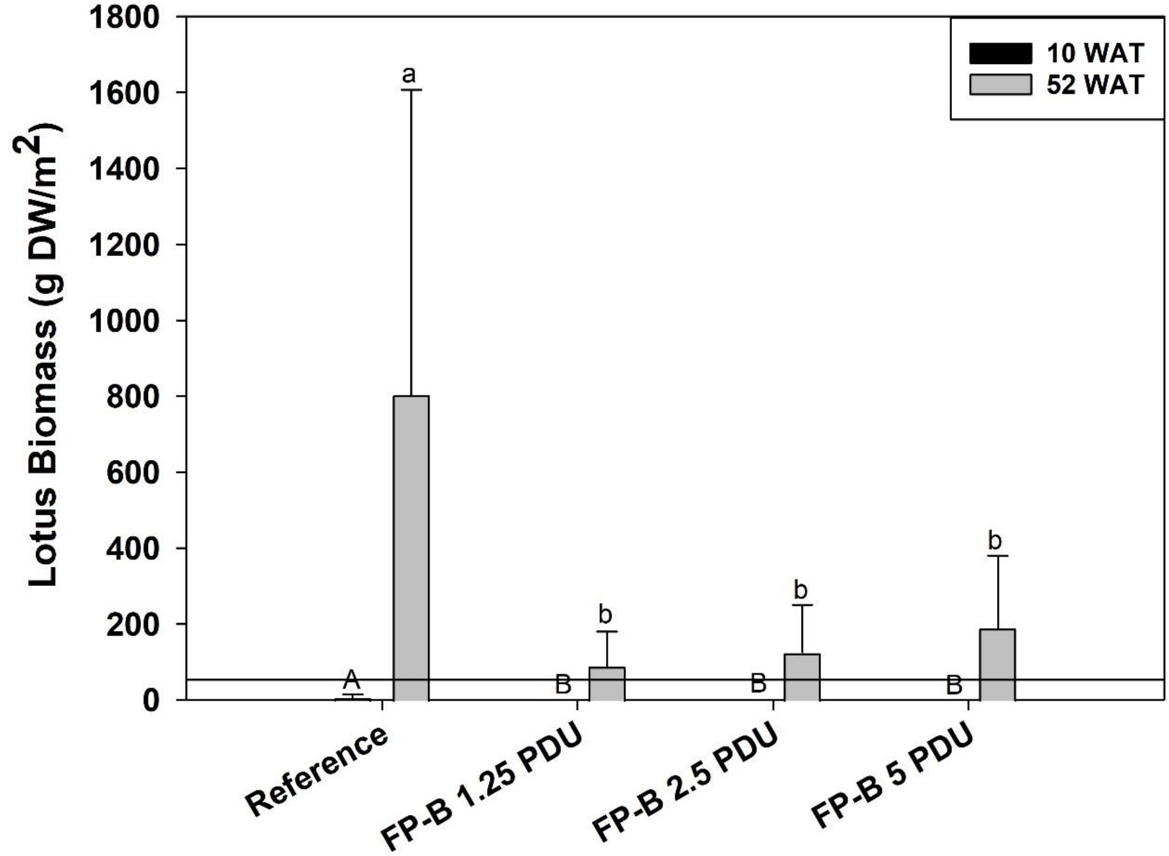

Figure 3. American lotus aboveground biomass harvested at 10 and 52 weeks after treatment (WAT) with Florpyrauxifen-benzyl (FP-B); separate analyses were conducted for each data collection event; error bars are one standard error of the mean; bars sharing a letter are not different at the alpha = 0.05 significance level (reference n=4 and treatment n=12); solid lines are pre-treatment means.

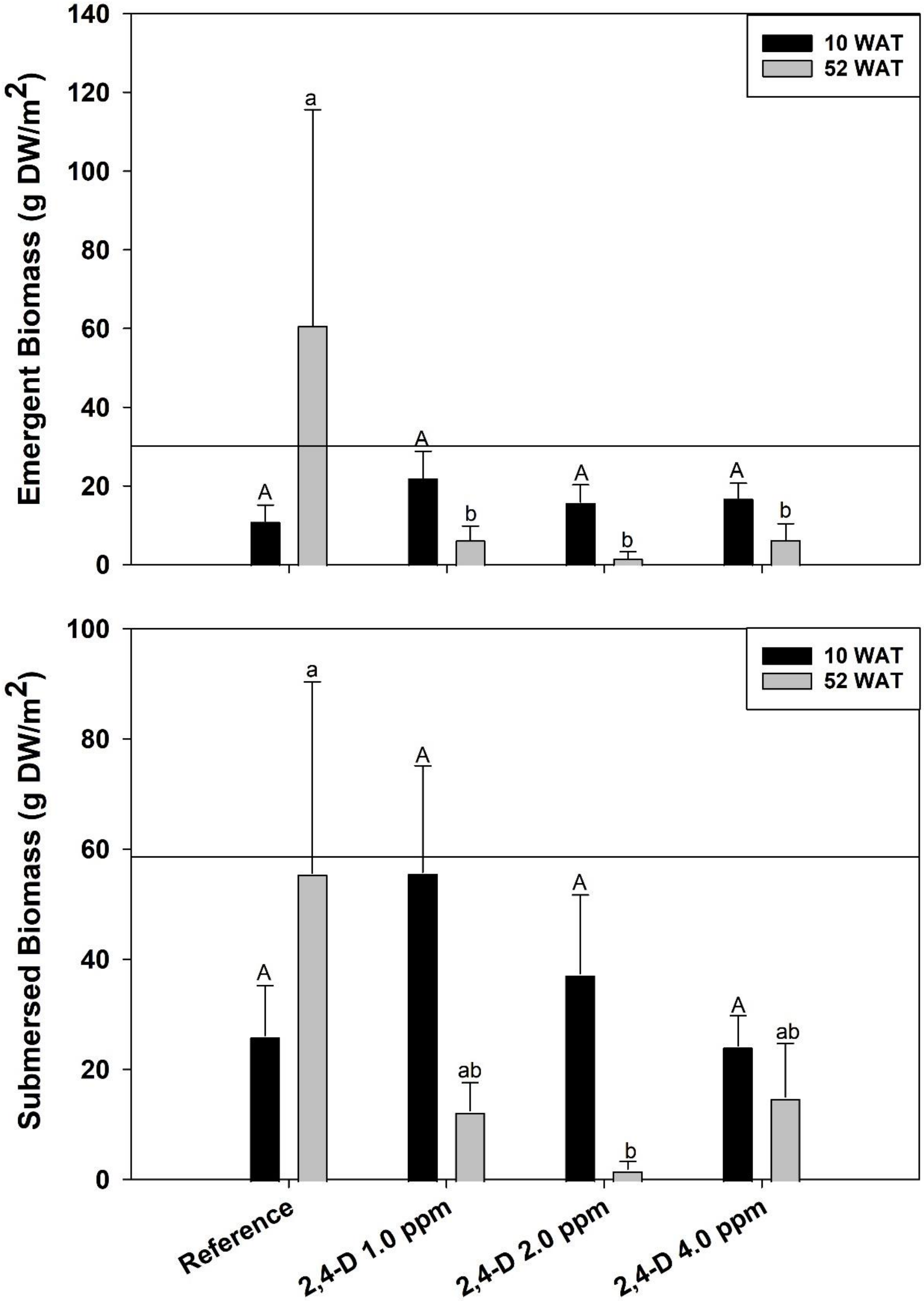

Figure 4. Emergent (top panel) and submersed (bottom panel) Cuban bulrush biomass harvested at 10 and 52 weeks after treatment (WAT) with 2,4-D; separate analyses were conducted for each data collection event; error bars are one standard error of the mean; bars sharing a letter are not different at the alpha = 0.05 significance level (reference n=4 and treatment n=12); solid lines are pre-treatment means.