The Efficacy of Repeated Herbicide Applications on the Control of Guineagrass (*Panicum maximum*)

at Caloosahatchee Regional Park, Lee County Florida

By Annisa Karim, David Mitchell, Laura Estabrook Carr, and Kenneth Langeland

Introduction

It has become abundantly clear that not all plants are created equally. Some plants have evolved successfully to compete with other plants by developing high rates of growth and reproduction, and producing numerous seeds or fruits that are easily dispersed by wind, water, small mammals or birds. Even so, these plants are controlled in their native ranges by natural enemies such as herbivores, pests and diseases. However, when transported to new areas outside of their native range, some of these plants can outcompete the native plants and are said to be invasive. Florida has seen the introduction of non-native plants for decades. *In the early 1900s, botanist and naturalist, Charles Torrey Simpson, warned, "There are the adventive plants, the wanderers, of which we have, as yet, comparatively few species; but later, when the country is older and more generally cultivated, there will surely be an army of them." (Simpson 1920)*

Caloosahatchee Regional Park (CRP) in northeastern Lee County consists of approximately 768 acres on the north side of the Caloosahatchee River. The park is about 2 miles west of the town of Alva and is managed by the Lee County Department of Parks and Recreation (LCPR). The park is divided by County Road 78 (North River Road). The last time the Caloosahatchee River was dredged, much of the dredge spoil was deposited onto the north side of the park (portion of CRP north of County Road 78), resulting in a highly altered topographic and hydrologic area, and an atypical terrestrial substrate. This portion of CRP has proven to be a serious management problem.

The park contains a diversity of plant communities, many of which have been impacted by invasive plant species. One of the dominant invasive plants is guineagrass (*Panicum maximum*). *P. maximum* is a large, clump-forming panic grass native to Africa. It has been introduced to tropical areas world-wide for fodder and has invaded wetlands, roadsides and disturbed lands in many of these areas. Guineagrass is a weed in natural areas of Florida (designated as a Category

Of the approximately 25,000 non-native plants imported into Florida (most as ornamentals), more than 1,400 have escaped and become established outside of cultivation (Florida Exotic Pest Plant Council 2011). The Florida Exotic Pest Plant Council (FLEPPC) maintains a list of exotic plants that have been documented to (1) have adverse effects on Florida's biodiversity and plant communities, (2) cause habitat loss due to infestations and (3) impact endangered species via habitat loss and alteration. FLEPPC categorizes the most problematic of these species into two categories. Category I plants are those that alter native plant communities by displacing native species, change community structures or ecological functions, or hybridize with natives. Category II plants have increased in abundance or frequency but have not yet altered Florida plant communities to the extent shown by Category I species. Land stewards and managers charged with protecting, preserving and restoring Florida's remaining native plant communities on public and private lands have found themselves spending increasing amounts of time and money in an attempt to control invasive, exotic plant species.

Table 1. Herbicide mixtures used in this study and cost per acre (September 2012 values) (excluding application costs). All treatments contained 0.05% non-ionic surfactant.

Herbicide Mixture	Rate/Acre	Cost/Acre
Alligare Glyphosate 4 Plus	6 qt	$34.95
Clearcast	2 qt	$21.00
Pendulum	2.4 qt	$14.72
Sahara	19 lb	$117.12
Alligare Glyphosate 4 Plus + Pendulum	6 qt + 2.4	$49.67
Alligare Glyphosate 4 Plus + Sahara	6 qt + 19 lb	$152.07
Alligare Glyphosate 4 Plus + Pendulum + Sahara	6 qt + 2.4 qt + 19 lb	$166.79

Table 2. Characteristics of herbicide active ingredients used in this study.

Active ingredient	Absorption/Translocation (predominant)[1]	Mechanism of Action[1]	Product used in this study
diuron	Root/Upward	Photosynthesis inhibitor (PS II)	Sahara
glyphosate	Foliar/Downward	Aromatic amino acid inhibitor (EPSP synthase)	Alligare Glyphosate 4 Plus
imazamox	Foliar/Upward and downward	Branched chain amino acid inhibitor (ALS)	Clearcast
imazapyr	Foliar and root/Upward and downward	Branched chain amino acid inhibitor (ALS)	Sahara
pendimethalin	Root and emerging seed root/Not translocated	Inhibits cell division and thus root growth	Pendulum

[1]Weed Science Society of America. 2007. Herbicide Handbook, Ninth Edition. WSSA Lawrence, KS

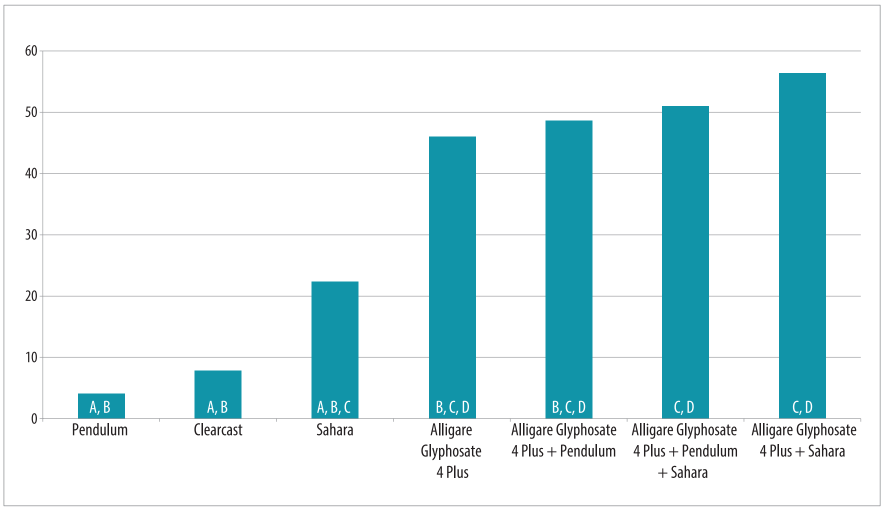

Figure 1. Percent control of guineagrass and Tukey's HSD post-hoc test results for each mixture tested (see Table 1 for rates per acre). Control is not significantly different among treatments with the same letter.

II invasive species by the Florida Exotic Pest Plant Council). It has been documented in 37 of Florida's 67 counties (Wunderlin and Hansen 2008) and is "commonly found as a weed in citrus groves and other disturbed and cultivated sites in the state" (Futch and Hall 2012).

On the north side of the park, guineagrass creates a monoculture over much of the dredge spoil from the river bottom. The south side (portion of CRP south of County Road 78) remains fairly intact with typical terrestrial soils, but continues to be impacted by invasive, exotic vegetation including guineagrass. Past land stewardship endeavors at CRP have resulted in minimal control of *P. maximum*. Traditional control methods included mowing the grass (if possible) and then spraying the re-growth at 6 to 8 inches in height with a 3% glyphosate (amino acid inhibitor) + 0.5% surfactant solution. While this method worked well in controlling plant matter above ground, the seeds of the guineagrass were not affected.

In an effort to maximize the efficiency of the herbicides, time and funds used to control guineagrass, LCPR staff partnered with the University of Florida's Institute of Food and Agricultural Sciences (UF/IFAS) to evaluate the efficacy of seven herbicide treatments (Table 1). Treatments included herbicide active ingredients with different modes of action (Table 2). Use of herbicides with different modes of action is important in preventing herbicide resistance in a management program. Herbicide resistance can develop in a weed population when herbicide sensitive plants are killed using repeat treatments with herbicides with the same mode of action. Some plants develop herbicide resistance and these plants will become dominant. "The single most important factor leading to the evolution of herbicide resistance is over-reliance on a single herbicide or group of herbicides with the same mode of action without using other weed management options" (Trujillo 2013).

Methods

An all terrain vehicle (ATV) equipped with a spray tank and spray boom was used to spray all plots. The sprayer was calibrated to deliver 50 gallons of solution per acre. All treatments contained 0.05% non-ionic surfactant in addition to the herbicides. Plots were sprayed in April 2010, October 2010, April 2011 and April 2012. October 2012 was too wet and windy for spraying to occur. A prescribed fire in December 2010 burned through one of the groups on the north side of CRP. The stakes delineating the plots were not burned and this group continued to be used in the study. Approximately five months after each spray event, guineagrass control was estimated by four individuals by comparing guineagrass in treated plots to untreated plots on a 0 to 100 scale (expressed as percent) where 0 represented no control and 100 represented complete control (Camper 1986). A final evaluation was conducted in October 2012.

Results and Discussion

A one-way repeated measures ANOVA indicated a significant [$F(6, 20) = 11.821$, $MSE = 847$, $p < 0.0001$]) treatment (herbicide mixture) effect. A post-hoc Tukey's Honest Significant Difference (HSD) test was used to test for differences between guineagrass control means (Figure 1).

After four applications of each herbicide mixture and twenty-five months after the initial application, the highest average control observed for all herbicide mixtures was only 56%, which demonstrates the difficulty of controlling guineagrass at CRP. The highest control was observed for those herbicide mixtures that contained glyphosate and there was no statistical difference among any of the glyphosate-containing mixtures, suggesting that there is no advantage to applying any of the other herbicides tested. This is especially true when considering the added expense of including the other herbicides (Table 1). Nor did pendimethalin, imazamox, or the mixture of imazapyr and diuron provide better control than glyphosate by itself. It can be concluded that repeat applications of a 3% glyphosate-containing product, which is equivalent to the six qt/ac rate used in this study and historically used for guineagrass control at CRP, should be continued as the management practice.

The development of herbicide resistance has been expressed as a threat to management of natural area weeds (Hutchinson et al. 2007). Globally, twenty eight weed species have developed resistance to the mechanism of action of glyphosate, ESPS synthase inhibition (Heap 2014). Already somewhat tolerant to glyphosate, guineagrass has the potential to develop increased resistance to glyphosate in response to repeated applications over time. To minimize the potential for resistance development, herbicides with different modes of action should be alternated. The herbicides with different modes of action tested in this study did not provide sufficient control to justify alternating with glyphosate. Therefore, further research is needed to find herbicides with different modes of action for control of guineagrass.

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