Effect of Pre and Post Emergence Herbicide Application Timing on Seedling Density of Hydroseeded *Fimbristylis cymosa*

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Received for publication

Paper is a portion of a thesis submitted by Orville C. Baldos in fulfilling a Master of Science degree in Tropical Plant and Soil Science (Ecology, Evolution and Conservation Biology).

We thank the State of Hawaii Department of Transportation and the United States Department of Agriculture - Natural Resources Conservation Service for providing financial support for this research. We thank the staff at the Hoolehua Plant Materials Center on Molokai for providing planting materials and technical assistance. We also thank Melinda Moata, the staff at the University of Hawaii Waimanalo Research Station and the Magoon Research Facility for their assistance in conducting the experiments.

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Subject Category:

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Additional index words. Oxadiazon, aminopyralid, fluazifop-p-butyl, native species revegetation

Abstract. A field study was conducted in 2008 to evaluate the optimum timing of pre and post emergence herbicide application in newly hydroseeded *Fimbristylis cymosa*. Seedling densities per square meter collected 92 days after hydroseeding (DAH) reveal that pre emergence applications of oxadiazon (2.0 lbs ai/acre) at 7 and 14 DAH greatly reduced the number of *Fimbristylis* seedlings. Plots treated with oryzalin (2.0 lbs ai/acre) at 7 and 14 DAH exhibited higher seedling densities than oxadiazon treated plots. However, plants were severely stunted compared to those recorded in untreated plots. Post applications of a tank mix containing oxadiazon (2.0 lbs ai/acre), aminopyralid (0.09 lbs ai/acre) and fluazifop-p-butyl (0.25 lbs ai/acre) at 28 and 42 DAH caused severe foliar injury that led to reduced seedling densities. Post applications of aminopyralid (0.09 lbs ai/acre) and fluazifop-p-butyl (0.25 lbs ai/acre) at 28, 42 and 56 DAH caused only slight foliar injury and did not show a significant reduction in seedling densities. Results from this study indicate that the post emergence herbicides, aminopyralid and fluazifop-p-butyl can be applied as early as 28 DAH to selectively control many broadleaf and grassy weeds on hydroseeded *F. cymosa*.

Hydroseeding is a well established method of large scale planting that is commonly utilized to re-vegetate roadsides. It involves the use of a water carrier for the application of seed under pressure (Beard, 1973) and it typically utilizes non-native grasses and legumes. In recent years, research and development of native seed mixes for hydroseeding operations have increased due to a growing interest in the use of native plants for roadside re-vegetation. In Hawaii, hydroseeding is currently being evaluated as a planting method for large scale roadside re-vegetation of several native plants. *Fimbristylis cymosa* is a native groundcover species that has been tested compatible with hydroseeding (Baldos, unpublished data). Locally known as mauʻu ʻakiʻaki (Hawaiian), this low growing sedge with stiff and leathery leaves possesses salt, wind and drought tolerance. It is commonly found on sandy beaches and rocky outcrops along the coastal areas of all main Hawaiian islands except Kahoolawe; elsewhere it is found in coastal areas of the Pacific basin including Australia, southeast Asia, Pacific islands and the Neotropics (Wagner et al., 1999).

Despite achieving success with hydroseeding, little is known about selective weed control for newly sown seeds of *Fimbristylis cymosa*. Timing of selective weed control during the seedling stage is essential in order to optimize the growing environment while minimizing injury to seedlings. The purpose of this study was to determine the optimal timing of pre and post emergence herbicide application for crop safety and weed control in hydroseeded *Fimbristylis cymosa*.

Materials and Methods

The field study was conducted at the University of Hawaii Waimanalo Research Station from August to November 2008. The experimental plot was located on an area where 2 different soil types converge. About half of the plot was a Haleiwa silty clay (fine, mixed, isohyperthermic Typic Haplustoll) while the other half was a Waialua clay (very fine, kaolinitic, isohyperthermic Typic Haplustoll). In order to reduce the effect of soil types, the experiment was blocked perpendicular to the soil gradient.

Minimally processed raw seed (dried, crushed seedheads with stem and leaf pieces removed) of *Fimbristylis cymosa* (HA#5866, 9079806) was used for the hydroseeding study. A seed count-germination test, started at the same time as the hydroseeding study, was conducted to determine the amount of live, germinable seed in a given weight of raw seed. Five 0.2 gram samples of raw seed were sown separately in unsealed square plastic dishes (Fisherbrand™ Square Dish with Grid (100 x 100 mm); Fisher Scientific, Pittsburgh, PA) lined with moistened filter paper (Whatman Filter Paper #3; Whatman International Ltd., Maidstone, United Kingdom). The sown seeds were allowed to germinate inside an incubator (Model I-30VL; Percival Scientific, Inc., Perry, IA) with alternating dark and light periods (12 hours each) as well as fluctuating day and night temperatures (20 to 26°C). The number of germinable seeds per sample was recorded by counting and removing germinated seeds on a weekly basis. Accumulated data collected within 4 weeks of monitoring was averaged to get the mean number of germinable seed per raw seed sample. Based on this study an average of 55 germinable seeds were present in a sample of raw seed.

Before the hydroseeding operation was conducted, any remaining weeds were removed from the field. The plot was divided into two 14 ft wide by 60 ft long sections to

ensure even and accurate distribution of the hydroseeding slurry. The hydroseeding operation was accomplished using a 50 gallon capacity hydroseeder (Turbo Turf Modular Hydroseeding System Model No. HS-50-M; Turbo Technologies Inc., Beaver Falls, PA). To facilitate mixing of a batch of hydroseeding slurry, both 3.9 kg straw mulch (HydroStraw®, HydroStraw LLC, Manteno, IL) and 7.8 kg paper mulch (NaturesOwn High Density Paper Hydroseeding Mulch, Hamilton Manufacturing Inc., Twin Falls, ID) were pre-wetted in buckets. The mulching materials including 200 grams of raw seed (containing approximately 55,000 germinable seeds) and 16.9 grams of tackifier (C:tac, Hamilton Manufacturing Inc., Twin Falls, ID) were thoroughly mixed with water inside the hydroseeder. After all components were mixed, the hydroseeder was filled with water to capacity in order to make one batch of slurry. One batch of hydroseeding slurry evenly covered an area of 840 ft^2 and sowed 705 viable seeds/m^2. To keep the plots constantly moist and to facilitate seed germination, overhead irrigation was supplied several times during the day (1.5 hours at 3:00 am and 15 minutes at 11:00 am, 2:00 pm and 5:00 pm).

The application of pre and post emergence herbicide treatments commenced 1 week after the hydroseeding operation was conducted. The herbicides used for this study was evaluated in a previous experiment and was determined as safe for mature *Fimbristylis cymosa* plants. The hydroseeded plot was divided into 4 blocks, each containing ten 6 ft by 7 ft experimental units. Herbicide treatments were randomly allocated to each unit within the block. The pre emergence herbicides, oxadiazon (Ronstar® 50 WSP; Bayer Environmental Science, Montvale, NJ) and oryzalin (Surflan® AS; United Phosphorus Inc., Trenton, NJ) were applied at 2.0 lbs ai/acre 7 and 14 days after hydroseeding (DAH). At 28 and 42 DAH, treatments which consisted of a tank mix containing aminopyralid (Milestone® VM; Dow

AgroSciences LLC, Indianapolis, IN) and fluazifop-p-butyl (Fusilade® DX; Syngenta, Greensboro, NC) were applied at 0.09 and 0.25 lbs ai/acre, respectively with or without oxadiazon (2.0 lbs ai/acre). At 28 DAH, a soluble preparation of oxadiazon (Ronstar® 50 WSP; Bayer Environmental Science, Montvale, NJ) was sprayed together with aminopyralid and fluazifop-p-butyl while at 42 DAH, a granular preparation of oxadiazon (Ronstar® G; Bayer Environmental Science, Montvale, NJ) was manually broadcasted before applying the post emergence tank mix. At 56 DAH, no pre emergence herbicides were applied with the post emergence tank mix. Also at this time period, weeds in the untreated (control) plots were cut to about 10 cm from the ground in order to prevent extreme shading. Seedling densities (number of seedlings/m^2) were collected at 92 DAH using a 1 x 1 m square frame as a measure of plant survival to pre and post emergence herbicide application.

Analysis of variance was performed on seedling densities using statistical analysis software (Statistix® 9; Analytical Software, Tallahasee, FL). Since data showed significance for non-additivity, a logarithmic transformation was performed before it was reanalyzed. Because most of the data entries were small values (e.g. less than 10) all data entries were transformed using the formula, log(x+1), where x = original data (Gomez and Gomez, 1984). Tukey HSD pairwise comparison tests were performed on seedling density data to separate treatment means.

Results and Discussion

Seedling density data reveal that pre emergence herbicide application is not advisable during the first 42 days after hydroseeding (Table 1). Spray applications of oxadiazon at 7 DAH resulted in extremely low seedling densities. No seedlings were observed in plots treated with oxadiazon at 14 DAH. Plots treated with oryzalin during the first 2 weeks after

hydroseeding exhibited significantly higher number of plants compared to those treated with oxadiazon at the same dates. Although seedling densities were statistically comparable to those recorded in untreated plots, the plants in the oryzalin treatments were severely stunted.

Spray applications of a tank mix containing oxadiazon, aminopyralid and fluazifop-p-butyl severely damaged foliar tissue of *F. cymosa* seedlings. Severe leaf dessication and necrosis led to complete mortality of plants in this treatment at 92 DAH. Granular applications of oxadiazon, when combined with post emergence sprays at 42 DAH did not result in a significant reduction of seedling density. However, treated seedlings showed signs of severe foliar injury from the granular application.

Although oryzalin could have been used for pre emergence control at 28, 42 and 56 DAH, it was not compatible with the post emergence herbicide mix of aminopyralid and fluazifop-p-butyl. Mixing oryzalin with these 2 post emergence herbicides led to the coagulation of the spray solution.

While oryzalin and oxadiazon cannot be used for weed control in newly hydroseeded *F. cymosa*, the post-emergence herbicides, aminopyralid and fluazifop-p-butyl can be safely used as early as 28 DAH. Plots that were treated with aminopyralid and fluazifop-p-butyl had seedling densities not significantly different from those in untreated control plots. Visual observations indicate that the 2 post emergence herbicides seem to have little to no detrimental impact on seedlings. Although slight yellowing and contortion of plants can be recorded 2 weeks after spraying the post-emergence mix, the plants were able to fully recover afterwards. Visual observations of weed control indicate that the tank mix of aminopyralid and fluazifop-p-butyl was effective in controlling most grassy and broadleaf weed species. The tank mix was particularly effective in controlling *Leucaena leucocephala*,

Portulaca oleracea, *Macroptilium atropurpureum* and *Amaranthus* spp. However, the post emergence mix did not control certain spurge species (*Chamaesyce* spp.) (data not presented).

Results obtained from this study indicate the importance of using specific herbicides at certain stages of native groundcover establishment. Application timing is essential for optimizing weed control while minimizing damage to establishing plants. For hydroseeded *F. cymosa*, only aminopyralid and fluazifop-p-butyl can be applied to control weeds. Post emergence control can be done as early as 28 DAH with minimum damage to seedlings. Although most grassy and broadleaf weed species are controlled by this herbicide mix, further studies on controlling of other weed species such as spurges is important in order to provide optimum growing conditions for fast establishment.

Literature Cited

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Tables

Table 1. Mean seedling density per square meter of the different pre- and post-emergence treatments 92 days after hydroseeding.

Herbicide Treatment	Herbicide rate (lbs ai/acre)	Application timing (days after hydroseeding)	Mean seedling density per m^2*
Oxadiazon (wettable powder, Ronstar® 50 WSP)	2.0	7	1.2 (0.25) c
Oryzalin (Surflan® 4 AS)	2.0	7	11.1 (3.35) ab
Oxadiazon (wettable powder, Ronstar 50 WSP)	2.0	14	1.0 (0.00) c
Oryzalin (Surflan® 4 AS)	2.0	14	19.2 (3.45) ab
Oxadiazon (wettable powder, Ronstar® 50 WSP) Aminopyralid (Milestone® VM) Fluazifop-p-butyl (Fusilade® DX)	2.0 0.09 0.25	28	1.0 (0.00) c

Aminopyralid (Milestone® VM) Fluazifop-p-butyl (Fusilade® DX)	0.09 0.25	28	73.9 (29.89) ab
Oxadiazon (granular broadcast, Ronstar® G) Aminopyralid (Milestone® VM) Fluazifop-p-butyl (Fusilade® DX)	2.0 0.09 0.25	42	9.6 (11.30) b
Aminopyralid (Milestone® VM) Fluazifop-p-butyl (Fusilade® DX)	0.09 0.25	42	36.2 (29.32) ab
Aminopyralid (Milestone® VM) Fluazifop-p-butyl (Fusilade® DX)	0.09 0.25	56	86.2 (23.77) a
Untreated	n/a	n/a	70.6 (39.69) ab

* Means followed by the same letters are not significantly different as determined by Tukey HSD at $P < 0.01$. Mean separation is based on log transformed means. Means presented are based on the antilog of the transformed mean with standard errors in parentheses (n = 4).