CROP TOLERANCE OF OAK SEEDLINGS IN HERBACEOUS WEED CONTROL APPLICATIONS USING INDAZIFLAM

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Abstract—Planting bareroot oak seedlings continues to account for substantial acreage across the South, especially on retired agricultural lands. It is now well established that good seedlings, good planting, and herbaceous weed control (HWC) are the trilogy of factors needed for consistently successful establishment. Survival exceeding 90 percent is now common when all three factors are satisfied. Even though research on HWC for oaks (*Quercus* spp.) began more than 25 years ago, the list of effective materials available for such use is still very short. Cost efficacy and crop tolerance remain the critical elements of evaluation for any new application. Indaziflam has shown promise for HWC applications in longleaf pine (*Pinus palustris*). In order to evaluate its use for oaks, six treatments were applied over the top of two species of recently planted oak seedlings at two planting sites in south Mississippi. All treatments were replicated three times at each site in these plantings of 1-0 bareroot seedlings. Plots were evaluated at 30, 60, 90, 120, and 150 days after treatment. Results indicate that indaziflam could be a useful alternative in oak plantings. The study provided a comparison of the indaziflam treatments to the current operational standard of post-plant sulfometuron methyl applications.

INTRODUCTION

Herbaceous weed control (HWC) in hardwood plantings continues to be an important consideration. Compared to similar practices in pine plantations, the list of approved chemicals is much more limited. That lack of materials combined with the occurrence of most hardwood plantings on retired agricultural areas which can have a much more established and competitive weed complex creates a serious challenge for hardwood managers on many sites.

Improved survival is the goal of herbaceous weed control in hardwoods. Survival may be increased 20–44 percent after the first growing season depending on the situation (Ezell and others 2007). Oust® XP was established as the "gold standard" for HWC in hardwoods almost 20 years ago (Ezell and Catchot 1998). However, evaluating new materials is always a worthwhile effort in the search for improved cost efficiency.

OBJECTIVES

The objectives of this study were to (1) evaluate crop tolerance of planted oak seedlings during the first growing season to treatments containing indaziflam (Esplanade®) and (2) evaluate efficacy of treatments in different field situations.

MATERIALS AND METHODS

Study Sites

A total of four study sites were utilized in south Mississippi: two sites in George County, MS (near Lucedale, MS) and two sites in Stone County, MS (near Wiggins, MS). All areas had been cleared after Hurricane Katrina seriously damaged or eliminated previous forest cover on the sites. Initial conditions on all sites were very similar to retired agricultural areas. Vegetation complexes varied greatly among sites, but all had well established competition including both grasses and forbs.

Treatments – A complete list of treatments is found in table 1. Treatments 1–6 were applied in both 2015 and 2016 while Treatment 7 was applied only in 2016.

Table 1—List of treatments in 2015 and 2016 Bayer hardwood studies

Trt. no.	Herbicide and rate per acre
1	Untreated
2	Oust® XP (2 oz.)
3	Esplanade® (3.5 oz.)
4	Esplanade® (7 oz.)
5	Oust® XP (2 oz.) + Esplanade® (3.5 oz.)
6	Oust® XP (2 oz.) + Esplanade® (7 oz.)
7 (2016 only)	Method® (6 oz.) + Esplanade® (7 oz.)

Note: line above Trt. no. 7 is to emphasize that this treatment was applied in only one year.

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Plot Layout and Experimental Design – Each plot consisted of an area 6 feet wide and 100 feet long. This represented 100 feet of a planted row with a 6-foot-wide spray area. Each plot contained a minimum of 10 planted oak seedlings.

Three replications of each treatment were installed both years. A randomized complete block design was utilized in all applications.

Application – All treatments were applied using a CO_2-powered backpack sprayer with a hand-held wand and single TK 2.5 Floodjet nozzle. These were banded applications using a 6-foot swath over the top of the planted seedling. The 2015 treatments were applied April 2, 2015 due to a delay in arrival of materials, and the 2016 treatments were applied March 16, 2016. All sites had greater than 80 percent coverage of competing vegetation at the time of application.

Species/seedlings – Three oak species were utilized in this study: Nuttall oak (*Quercus nuttallii*), Shumard oak (*Q. shumardii*), and swamp chestnut oak (*Q. michauxii*). Two species were included in each installation, with Shumard being utilized both years. In all plantings, high-quality 1-0 bareroot seedlings were utilized. Seedlings were obtained from a forest industry nursery in Mississippi and satisfied the minimum order specification requirements of ≥ 20-inch height above the root collar and a minimum of 10 first order lateral roots (FOLR). Seedlings were hand-planted in February, 2015 and February, 2016.

Evaluations – Plots were evaluated at 30, 60, 90, 120, and 150 days after treatment. All seedlings were examined for any signs of phytotoxic impact. An ocular estimate of the percent cover by grass or broadleaves was completed for each plot at each evaluation timing.

RESULTS

Field data were analyzed and means separation tests were applied. Due the general lack of statistical significance, no means separation is presented. Tabular information clearly defines the control (or lack thereof) in the treatments. In the 2015 trials, no treatments were successful in controlling the grass at the George County site (table 2). Coverage was well established at the time of application and increased with time. This was not unexpected, as the principal grass species on the site were cogongrass (*Imperata cylindrica*) and *Andropogon*, and Oust® XP is not effective on these species. Broadleaf forb control was excellent in the 2015 George County plots with all treatments giving good results (table 3). It is possible that grass coverage helped keep forb coverage low, but treated areas had less forb cover than the untreated check. Grass was well controlled by all treatments containing Oust® XP at the Stone County site in 2015 (table 4). Grass coverage at the site decreased throughout the evaluation period, but the 2-ounce-per-acre Oust® XP treatment had best overall results. By contrast, no treatments were effective at controlling all the broadleaf species at the Stone County site in 2015 (table 5). The Stone County site had common ragweed (*Ambrosia artemisiifolia*), horseweed (marestail) (*Erigeron canadensis*), goldenrod (*Solidago* spp.), and sicklepod (*Senna obtusifolia*). Thus, what was not controlled quickly covered any open areas. For example, Oust® XP controlled the ragweed but not sicklepod; Esplanade® provided sicklepod control, but not for ragweed.

In the 2016 trials, none of the treatments provided good grass control at the George County site (table 6). This was an old field setting with a number of grass species, and while most species were controlled, brown-top millet was not and quickly covered all plots. Treatments with Oust® XP did a good job of controlling forbs on the

Table 2—Average percent grass cover by treatment and time of observation – George County site (2015)

Trt.[a]	30	60	90	120	150
	----------*percent*----------				
Untrt.	90.0	93.7	96.3	96.3	96.7
O(2)	40.0	82.7	94.7	93.7	94.3
E(3.5)	80.0	90.0	95.0	94.3	95.7
E(7)	86.7	90.7	93.3	94.7	95.7
O(2) + E(3.5)	50.7	88.7	94.3	94.3	95.7
O(2) + E(7)	51.7	84.3	92.3	94.3	96.7

[a] Trt. = treatment [herbicide and rate (in ounces) per acre]. O = Oust® XP; E = Esplanade®.

Table 3—Average percent forb cover by treatment and time of observation – George County site (2015)

Trt.[a]	30	60	90	120	150
	----------percent----------				
Untrt.	15.0	13.3	13.3	13.3	13.3
O(2)	**1.0**	**0.7**	**1.3**	**1.5**	**1.7**
E(3.5)	**7.3**	**1.3**	**2.0**	**3.0**	**3.0**
E(7)	**5.0**	**1.3**	**2.7**	**2.3**	**2.7**
O(2) + E(3.5)	**3.0**	**1.0**	**2.0**	**2.0**	**2.0**
O(2) + E(7)	**2.7**	**1.0**	**1.3**	**1.3**	**2.0**

[a] Trt. = treatment [herbicide and rate (in ounces) per acre]. O = Oust® XP; E = Esplanade®.

Note: Values in bold are different from untreated at alpha=0.05.

Table 4—Average percent grass cover by treatment and time of observation – Stone County site (2015)

Trt.[a]	30	60	90	120	150
	----------percent----------				
Untrt.	80.0	46.3	13.7	16.7	19.3
O(2)	**5.0**	**8.3**	**2.7**	**2.7**	**3.3**
E(3.5)	77.0	16.7	**3.7**	**3.0**	**4.0**
E(7)	77.0	24.3	**2.3**	**6.0**	**6.3**
O(2) + E(3.5)	**4.3**	18.7	**3.0**	**8.3**	**7.0**
O(2) + E(7)	**1.0**	**7.3**	**5.3**	**8.0**	**9.0**

[a] Trt. = treatment [herbicide and rate (in ounces) per acre]. O = Oust® XP; E = Esplanade®.

Note: Values in bold are different at alpha=0.05.

Table 5—Average percent forb cover by treatment and time of observation – Stone County site (2015)

Trt.[a]	30	60	90	120	150
	----------percent----------				
Untrt.	15.3	75.0	100.0	92.3	95.0
O(2)	5.0	53.3	82.3	86.7	90.0
E(3.5)	10.0	76.3	88.3	92.3	93.3
E(7)	10.0	63.3	86.7	89.3	90.0
O(2) + E(3.5)	5.0	30.7	81.7	79.7	82.3
O(2) + E(7)	5.0	35.0	74.7	70.0	74.7

[a] Trt. = treatment [herbicide and rate (in ounces) per acre]. O = Oust® XP; E = Esplanade®.

George County site in 2016 (table 7). The combination of Oust® XP with the lower rate of Esplanade® (3.5 ounces per acre) provided better control than the combination using the higher rate (7 ounces per acre) of Esplanade®. This result was due to the distribution of one difficult-to-control species, but it does indicate that 3.5 ounces per acre of Esplanade® may be a sufficient amount for herbaceous weed control in many situations. At the Stone County site in 2016, none of the treatments provided good control of the grass species (table 8). This site had a very strong complex of grass species including cogongrass and tetraploid bahiagrass (*Paspalum notatum* Flüggé), neither of which is controlled by any of the treatments. Much of the plant diversity on this site may be attributed to various land uses since being cleared after Hurricane Katrina which include pasture, wildlife food plots, and gardening. Only the treatments containing Oust® XP provided acceptable broadleaf control on this site (table 9). As compared to the George County site of 2016, the higher rate of Esplanade® (7 ounces per acre) provided better control than the lower rate during the latter part of the growing season when combined with Oust® XP. This is attributed to the weed complex on the site.

Crop Tolerance – A major emphasis of these studies was to evaluate the crop tolerance of planted oak seedlings to indaziflam using the product Esplanade®. More than 750 seedlings were evaluated during the course of the two years of field trials. Of that total, the only seedlings

Table 6—Average percent grass cover by treatment and time of observation – George County site (2016)

Trt.[a]	30	60	90	120	150
	----------*percent*----------				
Untrt.	0.7	4.3	73.3	65.0	70.0
O(2)	0.0	4.0	96.7	93.3	80.0
E(3.5)	0.0	2.3	78.3	60.0	33.3
E(7)	0.0	3.0	31.7	31.7	18.3
O(2) + E(3.5)	0.0	0.7	90.0	91.7	85.0
O(2) + E(7)	0.0	1.0	53.3	76.7	50.0
M(7) + E(7)	0.0	6.0	63.3	65.0	80.0

[a] Trt. = treatment [herbicide and rate (in ounces) per acre]. O = Oust® XP; E = Esplanade®; M = Method®.

Note: line above Trt. no. 7 is to emphasize that this treatment was applied in only one year.

Table 7—Average percent forb cover by treatment and time of observation – George County site (2016)

Trt.[a]	30	60	90	120	150
	----------*percent*----------				
Untrt.	75.0	93.3	35.0	46.7	46.7
O(2)	**1.7**	**5.0**	**3.7**	**6.7**	**16.7**
E(3.5)	60.0	80.0	15.0	43.3	66.7
E(7)	65.7	70.0	41.7	66.7	35.0
O(2) + E(3.5)	**4.0**	**11.0**	**6.3**	**10.0**	25.0
O(2) + E(7)	**0.0**	**1.7**	**13.3**	25.0	33.3
M(7) + E(7)	**0.0**	**4.7**	**13.3**	28.3	**10.0**

[a] Trt. = treatment [herbicide and rate (in ounces) per acre]. O = Oust® XP; E = Esplanade®; M = Method®.

Note: Values in bold are different at alpha=0.05.

Note: line above Trt. no. 7 is to emphasize that this treatment was applied in only one year.

Table 8—Average percent grass cover by treatment and time of observation – Stone County site (2016)

Trt.[a]	30	60	90	120	150
	----------*percent*----------				
Untrt.	60.0	61.7	50.0	61.7	36.7
O(2)	23.3	71.7	100.0	95.0	94.3
E(3.5)	71.7	80.0	93.3	86.7	56.7
E(7)	66.7	70.0	66.7	76.7	60.0
O(2) + E(3.5)	43.3	70.0	96.7	71.7	85.0
O(2) + E(7)	25.0	56.7	98.3	88.3	86.7
M(7) + E(7)	91.7	100.0	100.0	96.7	86.7

[a] Trt. = treatment [herbicide and rate (in ounces) per acre]. O = Oust® XP; E = Esplanade®; M = Method®.

Note: line above Trt. no. 7 is to emphasize that this treatment was applied in only one year.

Table 9—Average percent forb cover by treatment and time of observation – Stone County site (2016)

Trt.[a]	30	60	90	120	150
	----------*percent*----------				
Untrt.	60.0	53.3	63.3	46.7	76.7
O(2)	**20.0**	**6.7**	**10.0**	**5.7**	**5.7**
E(3.5)	38.3	30.0	23.3	26.7	53.3
E(7)	41.7	36.7	46.7	28.3	43.3
O(2) + E(3.5)	20.0	**0.7**	**10.7**	33.3	25.0
O(2) + E(7)	**8.3**	**0.3**	**9.0**	**12.3**	**13.3**
M(7) + E(7)	**8.3**	**0.0**	**8.3**	**11.7**	**10.0**

[a] Trt. = treatment [herbicide and rate (in ounces) per acre]. O = Oust® XP; E = Esplanade®; M = Method®.

Note: Values in bold are different at alpha=0.05.

Note: line above Trt. no. 7 is to emphasize that this treatment was applied in only one year.

exhibiting any phytotoxic symptoms were those in plots treated with Method® (treatment #7 in 2016). Both Shumard and swamp chestnut oak seedlings were affected with swamp chestnut seedlings exhibiting more severe symptoms. However, this did not result in any additional mortality.

SUMMARY

Indaziflam appears to be safe for use over planted oak seedlings. This material provided best competition control when mixed with sulfometuron methyl (Oust® XP) and the mixture did not create any negative impacts on the seedlings. Control of all vegetation was less than desirable for most treatments, but the weed complexes on the study sites were more challenging than those usually encountered in oak plantings.

LITERATURE CITED

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