

# STAND DYNAMICS OF AN OLD-FIELD LONGLEAF PINE STAND FOLLOWING HERBICIDE APPLICATION, POOR SURVIVAL, AND SUBSEQUENT REPLANTING

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**Abstract**—A study area in Emanuel County, GA installed to discern the effectiveness of various herbicides over newly planted (December 1999) longleaf pine (*Pinus palustris* Mill.) seedlings on an old-field site. Survival and height growth data after herbicide treatment indicate that the early (April 7, 2000) Oust+Velpar L herbicide treatment gave greater initial survival and height growth compared to nine later herbicide treatments (May 9, 2000) or an untreated control. First year survival ranged from 90 percent with the April Oust+Velpar L treatment to 40 to 63 percent with the May herbicide treatments. All dead seedlings spots that were flagged and numbered were replanted in December 2000 in the May treatments and control plots. After six growing seasons, mean longleaf survival, d.b.h., height, and green weight per acre were greater with the April application. Sixth year survival ranged from 79 percent in the April application, 53 to 67 percent for the May herbicide treatments, and 41 percent for the control. In the May treatments, originally planted trees had significantly larger heights and diameters than the replanted trees. Original planted trees had an average diameter of 3.4 inches and height of 16 feet. Replanted trees had an average diameter of 1.9 inches and height of 9 feet. During the spring of 2000, rainfall patterns were well below normal. It appears that the early April herbicide treatment allowed for the seedlings to survive this critical dry period. These results indicate that substantial longleaf establishment costs can be saved with an earlier herbicide application under severe spring drought conditions on upland well drained soils.

## OBJECTIVES AND METHODS

The BASF Corporation was interested in testing various post-plant herbicides, individually and in combinations, over longleaf pine seedlings planted on an old-field site to determine herbicide effects on early survival and growth. The herbicides used were intended to control grasses and broadleaf weeds that were present on the site or expected to germinate on the site. The study area was a former 15-acre cotton field with the dominant soil being Tifton soil series (fine-loamy, well drained Plinthic Kandiudults) in Emanuel County, GA. Surface (0 to 6 inches) soil pH and available phosphorus over the study area ranged from 5.1 to 6.1 (mean of 5.5) and 29 to 83 (mean of 53) pounds per acre, respectively. Containerized longleaf seedlings were machine planted (7.25 by 12 feet spacing to achieve 500 stems per acre) in December 1999. The BASF study area was flagged off (approximately 5 acres) in early April. The operational treatment (2 ounce Oust per acre + 24 ounce Velpar L per acre) was applied on 7 April 2000 on the balance of the field. The BASF herbicide protocol treatments were applied by tractor and CO<sub>2</sub> sprayer at 15 gallons per acre on May 9, 2000 and are listed in table 1. The April and May herbicide treatments were applied once in a five-foot band over the top of the seedlings. The experimental design was randomized complete block with four replications per treatment and 40 (4 rows of 10) living seedlings per replication (as of May 8, 2000). All living seedlings were wire flagged, numbered, and followed initially for two years. Initial survival was tallied on 21 June 2000. First growing season survival was tallied on September 29, 2000 (table 2). Second year survival, number of seedlings out of the grass stage, and total heights were tallied on December 19, 2001. Dead seedlings were replaced

in December 2000 on all May 2000 treatment plots. The statistical analysis was performed on the May treatments and the control using ANOVA and least squares means were compared using Duncan's Multiple Range Test at the 5 percent alpha level. The means tested were seedling survival, percent seedlings out of the grass stage, and height of seedlings out of the grass stage during the first two years. The best five May 2000 treatments, the control, and the April 2000 treatment plots in replications 2, 3 and 4 were re-established in March 2006 in the interior two rows. Means tested at the end of the sixth growing season (measured March 2006) were survival, d.b.h., total height, and green weight per acre (estimated from log:log equations for green weight of wood+bark by Baldwin and Saucier (1983) x fraction survival x 500 trees per acre). Rainfall patterns during 2000 from the closest weather station in Vidalia (approximately 30 miles south-southeast of the study area) were compared to the 50 year running average (fig. 1).

## RESULTS

Initial longleaf seedling survival (June 21, 2000) after the banded herbicide applications ranged from 48 percent for the Arsenal at 8 ounces per acre to 74 percent for the Arsenal at 6 ounces per acre for the May treatments and 91 percent for the April Oust+Velpar L application and 62 percent for the control (table 2). There were no significant differences between the May treatments six weeks after treatment. End of the first growing season survival ranged from 40 percent for the Arsenal at 8 ounces per acre to 63 percent for the Arsenal at 6 ounces per acre for the May treatments and 90 percent for the April Oust+Velpar L treatment and 51 percent for the control (table 2). There were no significant

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*Citation for proceedings:* Stanturf, John A., ed. 2010. Proceedings of the 14<sup>th</sup> biennial southern silvicultural research conference. Gen. Tech. Rep. SRS-121. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 614 p.

**Table 1—Longleaf pine herbaceous weed control trial treatments on a former cotton field in Emanuel County, GA (fine-loamy well drained Tifton soil)**

| Code                 | Treatment <sup>a</sup>                                     | Application Date |
|----------------------|------------------------------------------------------------|------------------|
| <sup>b</sup> C       | Control, no treatment                                      | May 9, 2000      |
| <sup>b</sup> A4      | Arsenal 4 ounces per acre                                  | May 9, 2000      |
| <sup>b</sup> A6      | Arsenal 6 ounces per acre                                  | May 9, 2000      |
| A8                   | Arsenal 8 ounces per acre                                  | May 9, 2000      |
| <sup>b</sup> A4O2    | Arsenal 4 ounces per acre and Oust 2 ounces per acre       | May 9, 2000      |
| <sup>b</sup> A4OS6.5 | Arsenal 4 ounces per acre and Oustar 6.5 ounces per acre   | May 9, 2000      |
| A4P1.2               | Arsenal 4 ounces per acre and Pendulum 1.2 quarts per acre | May 9, 2000      |
| A6P1.2               | Arsenal 6 ounces per acre and Pendulum 1.2 quarts per acre | May 9, 2000      |
| A4V24                | Arsenal 4 ounces per acre and Velpar L 24 ounces per acre  | May 9, 2000      |
| <sup>b</sup> OS13    | Oustar 13 ounces per acre                                  | May 9, 2000      |
| <sup>b</sup> 02V24   | Oust 2 ounces per acre and Velpar L 24 ounces per acre     | April 7, 2000    |

<sup>a</sup>Treatments were applied over the top of the longleaf seedlings in a five feet band with a tractor/sprayer system at 15 gallons per acre.

<sup>b</sup>treatments that were followed for six growing seasons in replications 2, 3, and 4.

differences between the May treatments at the end of the first growing season (table 2). Survival at the end of the second growing season (all May treated plots and control plots were replanted in December 2000) ranged from 58 percent for the May Arsenal+Pendulum treatment to 91 percent for the Arsenal+Oustar for the May treatments and 90 percent for the April Oust+Velpar L treatment and 64 percent for the control. Second year survival for the Arsenal+Oustar treatment was significantly greater than the control, Arsenal at 6 ounces per acre, and the Arsenal+Pendulum treatments (table 2). Percent trees out of the grass stage ranged from 30 percent for the Arsenal at 8 ounces per acre and Arsenal+Pendulum treatment to 54 percent for the Arsenal+Oustar for the May treatments. There were no significant differences in percent seedlings out of the grass stage among the May treatments (table 2). The April Oust+Velpar L treatment had 81 percent of seedlings out of the grass stage at the end of the second growing season (table 2). Mean longleaf seedling height at the end of the second growing season ranged from 0.7 feet for the control and Arsenal+Pendulum treatment to 1.3 feet for the Arsenal+Velpar L treatment. There were no significant differences between the May treatments for year two

height (table 2). The April Oust+Velpar L treatment longleaf seedlings were taller (1.6 feet) than all the May treatments by 0.3 to 0.9 feet at the end of the second growing season (table 2).

There were no significant differences for six year survival, d.b.h., height, or green weights per acre between the May treatments (table 3). May treatment six year survival ranged from 41 percent for the control treatment to 67 percent for the Arsenal+Oustar treatment (table 3). The April Oust+Velpar L treatment six year survival was 79 percent (table 3). Six-year heights ranged from 12.7 feet (Arsenal at 4 ounces per acre) to 13.7 feet (control) for the May treatments and 16.5 feet for the April Oust+Velpar L treatment (table 3). Six-year d.b.h ranged from 2.7 inches (Oustar at 13 ounces and Arsenal at 4 ounces per acre treatments) to 3.1 inches (Arsenal at 6 ounces per acre) and 3.5 inches for the April Oust+Velpar L treatment. Six-year green weight per acre estimated ranged from 5 994 pounds (Arsenal at 4 ounces per acre) to 9 579 pounds (Arsenal at 6 ounces per acre) for the May treatments and 18089 pound for the April Oust+Velpar L treatment (table 3).

**Table 2—Longleaf pine herbaceous weed control trial mean survival, percent trees out of the grass stage, and height by treatment and measurement period on a former cotton field in Emanuel County, GA (fine-loamy well drained Tifton soil)**

| Application date  | Treatment code <sup>a</sup> | Initial survival | Year one survival | Year two              |                          |        |      |
|-------------------|-----------------------------|------------------|-------------------|-----------------------|--------------------------|--------|------|
|                   |                             |                  |                   | Survival <sup>c</sup> | Trees out of grass stage | Height |      |
|                   |                             |                  |                   |                       |                          |        |      |
| -----percent----- |                             |                  |                   |                       |                          |        | feet |
| May 2000          | <sup>b</sup> C              | 62               | 51                | 64cd                  | 32                       | 0.7b   |      |
| May 2000          | <sup>b</sup> A4             | 64               | 54                | 76abcd                | 43                       | 0.8b   |      |
| May 2000          | <sup>b</sup> A6             | 74               | 63                | 74abcd                | 47                       | 0.9b   |      |
| May 2000          | A8                          | 48               | 40                | 64cd                  | 30                       | 0.8b   |      |
| May 2000          | A4O2                        | 61               | 56                | 81abc                 | 52                       | 1.2a   |      |
| May 2000          | <sup>b</sup> A4OS6.5        | 65               | 58                | 91a                   | 54                       | 1.2a   |      |
| May 2000          | A4P1.2                      | 49               | 44                | 58d                   | 35                       | 0.8b   |      |
| May 2000          | A6P1.2                      | 66               | 56                | 69bcd                 | 30                       | 0.7b   |      |
| May 2000          | A4V24                       | 54               | 48                | 84ab                  | 41                       | 1.3a   |      |
| May 2000          | <sup>b</sup> OS13           | 52               | 44                | 84ab                  | 42                       | 1.2a   |      |
| April 2000        | 02V24                       | 91               | 90                | 90                    | 81                       | 1.6    |      |

<sup>a</sup>Refer to Table 1 for full treatment descriptions.

<sup>b</sup>Treatments that were followed for six growing seasons.

<sup>c</sup>Means followed by a different letter within a measurement period are significantly different using Duncan's Multiple Range Test at the 5 percent alpha level for the May treatments.

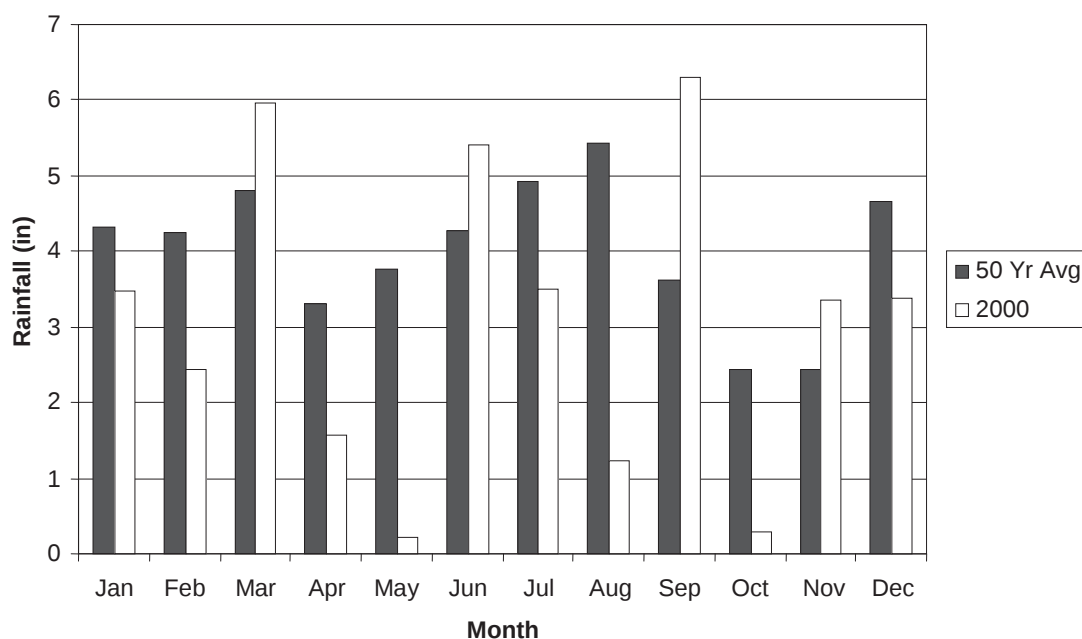


Figure 1—Vidalia, GA weather station rainfall patterns for the year 2000 and the 50 year average.

**Table 3—Longleaf pine herbaceous weed control trial mean survival, height, d.b.h., and green weight per acre by treatment through March 2006 on a former cotton field in Emanuel County, GA (fine-loamy well drained Tifton soil)**

| Treatment date | Treatment code <sup>a</sup> | Year six       |             |               |                        |
|----------------|-----------------------------|----------------|-------------|---------------|------------------------|
|                |                             | Survival       | Height      | D.b.h.        | Green weight           |
|                |                             | <i>percent</i> | <i>feet</i> | <i>inches</i> | <i>pounds per acre</i> |
| May 2000       | C                           | 41             | 13.7        | 3.0           | 6003                   |
| May 2000       | A4                          | 53             | 12.7        | 2.7           | 5994                   |
| May 2000       | A6                          | 59             | 14.4        | 3.1           | 9579                   |
| May 2000       | A4O2                        | 60             | 13.6        | 2.9           | 8482                   |
| May 2000       | A4OS6.5                     | 67             | 13.4        | 2.9           | 8026                   |
| May 2000       | OS13                        | 66             | 12.9        | 2.7           | 9270                   |
| April 2000     | 02V24                       | 79             | 16.5        | 3.5           | 18089                  |

<sup>a</sup>Refer to Table 1 for complete treatment description.

There were no significant differences between the May treatments six growing seasons after application.

## SUMMARY AND DISCUSSION

Although the April 7, 2000 Oust+Velpar L banded herbicide treatment could not be statistically compared to the May treatments, it outperformed all the May 9, 2000 treatments and the control treatment for initial survival, first year survival, second year survival, percentage of trees out of the grass stage, second-year height, and six-year survival, d.b.h., height, and green weight per acre. The April Oust+Velpar L treatment area did not need a re-plant with 90 percent survival whereas the May treatments and the control plots were re-planted at the landowner's request. Second-year planted (December 2000) longleaf pines were compared to first-year (December 1999) planted longleaf in the May herbicide treated plots for d.b.h. and total height. The mean d.b.h. (3.4 inches) and total height (16.0 feet) from the first-year planted longleaf were significantly greater than the second-year planted longleaf (1.9 inches and 9.0 feet, respectively). There was not a second year (spring of 2001) banded herbicide application over any of the plot longleaf seedlings.

South Georgia experienced an excessive drought during 2000. The Vidalia weather station rainfall during 2000 was 11.4 inches below the fifty year average of 48.2 inches (fig. 1). Historically, April and May have been the two months with the lowest rainfall during the first half of the year for all interior Georgia Coastal Plain weather stations. April and May rainfall in 2000 totaled 1.8 inches, whereas the historic average is

7.1 inches for the Vidalia weather station. The April and May 2000 rainfall deficit accounted for 46.5 percent of the entire year's rainfall deficit. Note that the majority (81 percent on average) of first year mortality occurred between 8 May and 21 June for all treatments and the control during this very droughty period. For example, as of June 21, 2000 (six weeks after the May treatments and ten weeks after the April treatment) mortality ranged from 26 to 52 percent in the May herbicide treated plots and 9 percent in the April Oust+Velpar L plots (table 2). The end of the first growing season mortality ranged from 37 to 60 percent for the May treatments and 10 percent for the April treatment (table 2). This study illustrates that an early herbicide application on well drained upland soils during droughty spring conditions can be crucial for early survival, growth, stand uniformity, and reduce the need for replanting.

## ACKNOWLEDGMENTS

The authors would like to thank the BASF Corporation for supporting this study during the first two years and DuPont for supporting the study during year six.

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