Burning and 2, 4, 5-T Application on Mortality and Carbohydrate Reserves in Saw-palmetto

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Abstract

On the flatwoods of the southeastern United States control of saw-palmetto (*Serenoa repens* (Bartr.) Small) is an important step in the improvement of native pastures. This study, conducted at the Ona Agricultural Research Center in south Florida, measured fluctuations in total available carbohydrates (TAC) in rhizomes of burned and unburned saw-palmetto which received a June or October application of 8.9 kg/ha (acid equiv.) of 2,4,5-T. Palmetto kill, change in palmetto cover, and grass canopy cover were evaluated. Burning reduced TAC concentration in rhizomes from 48.8% in March to 14.3% in July as compared to a drop from 47.2% to 37.4% for unburned plants. Applying 2,4,5-T caused a further significant decline in TAC concentration. Both burning and 2,4,5-T resulted in lower rhizome percent dry matter indicating that treatment stress caused metabolism of carbohydrate which was replaced by water. After 1 year there was higher mortality on palmetto receiving 2,4,5-T in June, but after 2 years there was no difference in mortality between June (48%) and October sprayed (39%) plants. Burning was not found to have a significant effect on mortality of sprayed plants. Burning and 2,4,5-T decreased palmetto cover, and burned plants treated with 2,4,5-T in June had less cover than burned plants treated in October with 2,4,5-T. Burning followed by 2,4,5-T application in June increased grass cover from 29.4% at the beginning of the study to 67.5% at the end.

Saw-palmetto (*Serenoa repens* (Bartr. Small)) is one of the most abundant shrubs on the sandy flatwoods from southern South Carolina to southern Mississippi and throughout all of Florida. The primary method of reproduction is by sprouting from partially buried stems or rhizomes which are capable of elongation. However, palmettos flower in late April and produce some fruit in September or October. In Florida palmettos are relatively dormant in the winter and produce 80% of their annual growth during the rainy May to October period (Hilmon 1968). Carbohydrate reserves of saw palmetto are principally starch which is stored in the rhizomes (Hough 1968). These reserves follow seasonal cycles which are influenced by periods of dormancy, frond growth, and flowering. In rhizomes of unburned plants grown in Georgia, starch was highest in winter (37%) and lowest in summer (27%).

Florida cattlemen burn range every 3 to 4 years after winter grazing in order to remove old forage and litter, but palmettos regain 80% of their crown coverage the first year after burning (Hilmon 1968). Burning significantly lowered plant reserves, and three repeated summer burnings after a winter burn lowered starch to 12% (Hough 1968).

Interest in reducing palmetto cover has increased with demands for forage production. McCaleb et al. (1960) tested 25 chemicals and reported 2,4,5-T to be among the best for killing saw palmetto. Recent preliminary experimentation (unpublished) conducted at the Ona Agricultural Research Center (ARC) supports 2,4,5-T (2,4,5-trichloro-phenoxyacetic acid) as being the best of 10 compounds. McCaleb et al. (1961) applied herbicides to unburned palmettos in September and October and reported better mortality (75%) with 4.48 kg acid equivalent/ha (AE/ha). Burton and Hughes (1961) evaluated mortality at 20 months after the application of 3 rates of 2,4,5-T and 2 carriers applied at 3 dates to burned and unburned palmettos. They reported that main effects due to burning and rates were not significant, and date of application was significant only on burned palmettos where the best treatment (burn on March 7 and spray August 26 with 2,4,5-T and water) resulted in 76% mortality. Altobellis and Hough (1968) experimented with 7 combinations of burning and spraying of 2 rates of 2,4,5-T. Best control (61%) was obtained with 6.16 kg/ha AE applied in July 1963, burning 7 months later, respraying in July 1964 followed by reburning in July 1965. The success of this treatment was evaluated with reference to the carbohydrate reserve work of Hough (1968), although there was no report of starch analyses in this study.

Because burned palmettos have a weaker energy status than unburned plants (Hough 1968), burning may predispose plants to greater mortality (Burton and Hughes 1961, Altobellis and Hough 1968) when sprayed with 2,4,5-T, which is effective in killing palmettos (McCaleb et al. 1960, McCaleb 1961, Grelen 1960, Burton and Hughes 1961, Altobellis and Hough 1968). However, time of application after burn still remains on a trial and error basis. Hough (1968) suggested that based on this carbohydrate reserve work, October application of herbicide would probably result in the best kill of winter burned palmettos. However, since carbohydrates in unburned palmettos are at their lowest level in late June and July (Hough 1968), this would be an appropriate time for herbicide application which would likely result in maximum control of unburned palmettos. The objective of this study was to measure the total available carbohydrate and relate this to mortality of winter burned and unburned palmettos which were sprayed with 2,4,5-T in June and October.

Materials and Methods

Work was conducted at the University of Florida's Ona ARC (27° 26′N, 81° 55′W) in south-central Florida. Average annual rainfall is about 140 cm, 75% of which falls from May to October. Average temperatures from May to October are maximum/minimum 31.6/17.8°C while the remaining months average 25.3/11.6°C. Soil on the experimental site was a Eau Gallie fine sand (Arenic haplaquod), which supported a uniform stand of saw-palmettos that had not been burned in the past 10 years.

The treatments were: (1) burn (March 1, 1977) and no burn; and (2) time of 2,4,5-T (propylene glycol, butyl ether esters) application at 8.9 kg AE/ha applied on June 30, 1977, or October 20, 1977, in

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440-liter/ha spray volumes. This experiment was a split plot in burn (mainplot) and time of herbicide application (subplot) treatments. Main plots (10 × 6m) were arranged in 4 randomized, complete blocks.

Sub-plots were sampled 15 times on regular intervals between March 3, 1977, and February 21, 1979, and determinations were made for palmetto and grass canopy cover (ocular estimates), percent palmetto mortality, rhizome dry matter, and total available carbohydrate.

Within each sub-plot a 5-m² quadrat was established and maintained during the course of the experiment. An accurate count of palmetto crowns in the quadrats was made, and these initial counts were used as a basis of calculating percent mortality. A crown and its meristem were considered dead when the newly emerging dead frond could easily be pulled from the bud. At this stage the meristem at the end of the petiole was necrotic.

From outside the 5-m² quadrat 2 living rhizomes of similar size were exhumed, the scales chopped away and 4, 2.5-cm holes were drilled through the rhizome at points beginning 10 to 12 cm behind the meristem. A metal plate with a 2.5-cm hole in the center was placed with its hole over the place in the rhizome to be drilled. The drill bit went through the hole in the plate and shavings from the rhizome were collected around the hole in the plate. Shavings were dried overnight at 100° C for dry matter determination then ground to pass through a 40-mesh screen.

The total available carbohydrates in palmetto rhizomes were extracted using the enzymatic procedure described by Smith (1969). Modifications were: (1) amylo-glucosidase and invertase was used in addition to takadiastase enzyme, (2) the filtrate was not treated after enzyme hydrolysis with lead acetate and potassium oxalate. Hough (1968) found that the available carbohydrates of palmetto rhizomes to be mainly starch with the only sugars being sucrose, glucose, and fructose. Thus, the use of invertase plus starch-hydrolyzing enzymes eliminated the need for acid hydrolysis of the extract. The extract was analyzed for reducing sugars using the Nelson-Somogyi colorimetric test using glucose as a standard (Nelson 1944; Somogyi 1952). Results were reported as starch equivalent as a percent of total dry matter.

Results and Discussion

Total Available Carbohydrate (TAC) and Dry Matter (DM)

Examination of main effect means (solid lines in Fig. 1) indicates that on every sample date from April 20, 1977, (sample period 2) to January 20, 1978 (sample period 8), burning significantly reduced

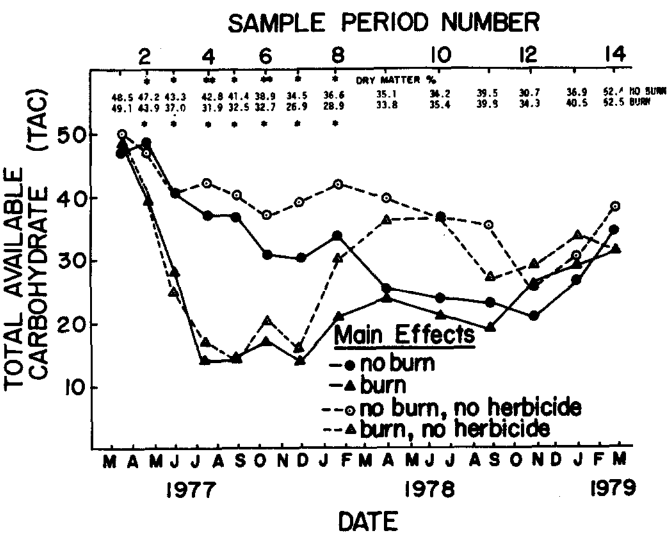

Fig. 1. *Average effects of burning vs not burning on the total available carbohydrate and dry matter percentage in saw palmetto at 14 dates after a winter burn. Ona, Fla. 1977-79.*
* *Significant at P<0.05.*
***Significant at P<0.01.*

TAC concentration (Fig. 1). Total available carbohydrate of burned palmettos dropped rapidly from 48.8% (March 3, 1977) to 14.3% (July 20, 1977), and the values did not rise until after January 1978. Burned and unburned palmettos were similar in TAC (25.4 and 24.0%, respectively) on April 20, 1978 (sample 9), and they were not significantly different for the remainder of the experiment. Hough (1968) reported that reserves in burned palmettos required 3 to 4 years to recover in Georgia, and these data indicated that 50% of the TAC was returned after little more than 1 year. In either case TAC recovery after burning was during winter.

Because main effect means for burning are averaged over times of herbicide application, the graphic effects of burning on TAC may be misleading. Plotted with main effects are the effects of the burn and no burn, no herbicide treatments (Fig. 1). Comparison of TAC from these treatments between sample period 2 and 9 shows the true effect of burning.

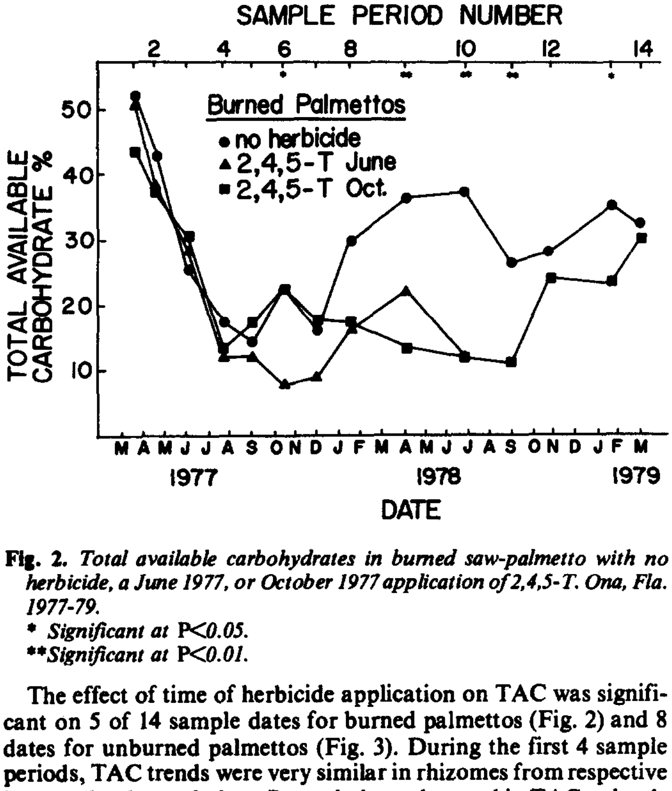

Fig. 2. *Total available carbohydrates in burned saw-palmetto with no herbicide, a June 1977, or October 1977 application of 2,4,5-T. Ona, Fla. 1977-79.*
* *Significant at P<0.05.*
***Significant at P<0.01.*

The effect of time of herbicide application on TAC was significant on 5 of 14 sample dates for burned palmettos (Fig. 2) and 8 dates for unburned palmettos (Fig. 3). During the first 4 sample periods, TAC trends were very similar in rhizomes from respective burn and unburned plots. Burned plants dropped in TAC to levels of 12 to 17% around July 20, (Fig. 2) at about the same time that unburned plants reached low levels of 34 to 36% TAC (Fig. 3). After 2,4,5-T application on June 30, the TAC in burned rhizomes continued to drop to their lowest levels (7.8%), then started to rise at sample period 6, reached a high point at April 1978 (period 9), then dropped off rapidly (Fig. 2). Burned rhizomes with June 2,4,5-T application followed TAC trends similar to the untreated plants, but did not recover after July 1978. When 2,4,5-T was applied in October (period 6), TAC patterns no longer resembled other treatments because TAC continued to decline until September 1978 (period 11), after which TAC began to increase along with that of the no herbicide treatment.

After application of 2,4,5-T in June, rhizomes from unburned plants continued to decline to a low TAC level of 15.9% (Fig. 3), and like rhizomes from burned, June-2,4,5-T treated plants, they increased in TAC along with the check until January 1978. This was several months sooner than the high point reached by burned, June 2,4,5-T plots (Fig. 2). When 2,4,5-T was applied in October (period 6), TAC patterns steadily declined for the next 11 months to a low level of 10.5%. Like the rhizomes from burned, October-2,4,5-T-treated plants, they increased in a fashion similar to the nonherbicided plants.

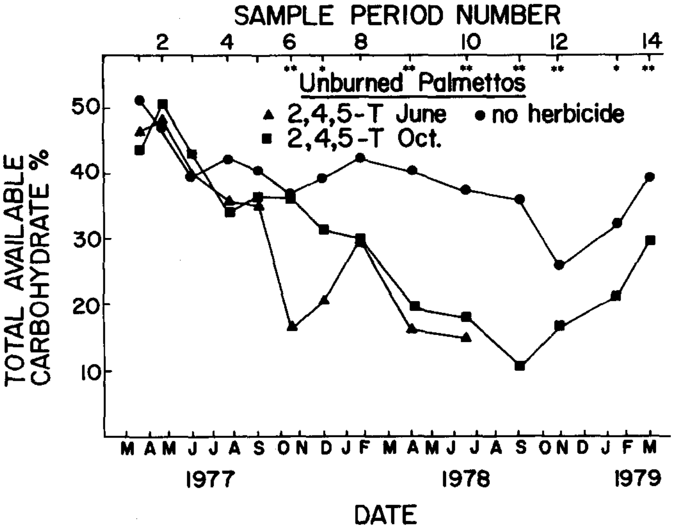

Fig. 3. *Total available carbohydrates in unburned saw-palmetto with no herbicide, a June 1977, or October 1977 application of 2,4,5-T. Ona, Fla. 1977–79.*
* *Significant at* P<*0.05.*
***Significant at* P<*0.01.*

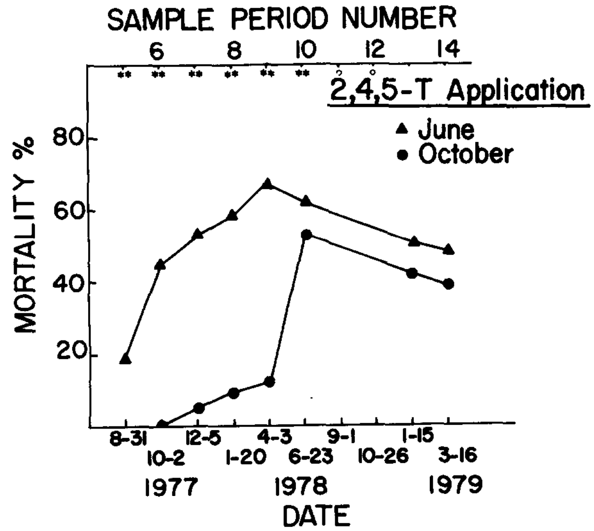

Fig. 4. *Average mortality of burned and unburned saw-palmetto treated with 2,4,5-T in June or October, 1977. Ona, Florida. 1977–79.*
* *Significant at* P<*0.05.*
***Significant at* P<*0.01.*

Burned plants had an average of 3 to 4 new fronds in June and 4 to 5 in October. In addition to being lower in TAC, it is believed that new fronds had higher metabolic rates than older fronds of unburned plants. The younger fronds may have been able to absorb and translocate 2,4,5-T at a more rapid rate than older fronds.

Results of the analyses of percentage dry matter in the rhizomes are summarized in Figure 1. A significant difference due to burn was found in 7 of the first 10 dates, but no effects due to burning were detected after January 20, 1978 (sample 8). In each case the effects of burning were independent of treatment, and the higher rhizome dry matter was found on the nonburned plots, which was also found by Hough (1969). Significant differences in dry matter were found among time of application treatments on 7 of the final 11 dates (data not in figures). The no herbicide plots were always highest in dry matter, and the rhizomes from the June-applied treatment were lowest in 5 of the 7 instances of significance.

Significant differences in rhizome dry matter were found whenever there were significant differences in available carbohydrate. This close association between dry matter and carbohydrate content would indicate that stress such as burning or herbicide application would cause the plant to use the starch for growth and replace it with water.

Mortality and Cover

Percent palmetto mortality was measured 8 times beginning August 31, 1977. This response was defined as the ratio of the number of dead meristems to the average number of crowns found for the first three sample dates. Burning had no significant effect on mortality, but time of herbicide application had a significant effect on palmetto mortality at sample dates 5 through 10 (Fig. 4). On the first 5 dates it was found that mortality was highest with the June application with no difference being detected between the October application and the check. In April 1978 there was only 12% mortality in those palmettos sprayed in the previous October, but by June 1978 the mortality had risen to 52.5%, which was similar to the mortality in the June-sprayed group. At the final dates there was no significant difference due to the month of application. The mortality percentages declined for both treatments because of resprouting from what we believed to be dead rhizomes.

Average mortality between August 1977 and February 1980 of burned and unburned palmettos with a June 2,4,5-T application was 56.6% and 43.9%, and mortality of burned and unburned plants with an October 2,4,5-T application was 22.4% and 17.8%.

A pooled analysis of variance over dates was performed to test differences in palmetto cover due to burning and time of 2,4,5-T application. Palmetto cover was measured on 12 sample dates, and was found to be significantly reduced by burning on the first 5 sample dates. Time of application of 2,4,5-T significantly decreased palmetto cover at 7 sample dates (data not in figures). The amount of cover from burned and unburned plants depended on sample date. Cover was high on unburned palmettos during the first sample periods, then as palmettos regrew, cover of burned palmettos equaled that of the unburned plants. The amount of palmetto cover from burned or unburned plants also depended on time of 2,4,5-T application (Fig. 5). Average palmetto cover on nonherbicide plots was 72%; 34% on June apllied 2,4,5-T, and 60% on October applied 2,4,5-T. The effect that time of application had on palmetto cover depended on burning. When 2,4,5-T was applied in June, the difference between burned and unburned palmetto cover averaged 20 percentage units, but when 2,4,5-T was applied in October, the difference between burned and unburned palmetto cover averaged only 6 percentage units.

Grasses which made up the ground cover were as follows (greatest cover to least): *Aristida stricta* Michx., *Schizachyrium stolo-*

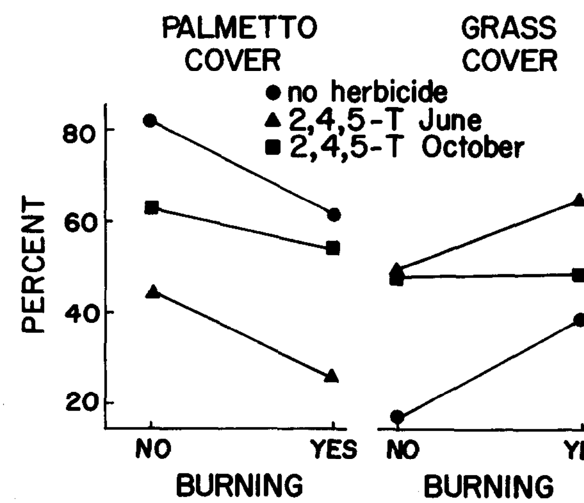

Fig. 5. *Saw-palmetto and grass cover of burned and unburned plants sprayed in June or October, 1977 with 2,4,5-T. Ona, Fla. 1977–79.*

niferum Nash, *Panicum* and Paspalum spp., *Andropogon capillipes* Nash, *A. virginicus* L., *Sorghastrum secundum* (Ell.) Nash, *Aristida spiciformis* Ell., *Andropogon cabanisii* Hack., and *Panicum anceps* Michx. When the cover due to those grasses was examined through pooled analyses over sample dates, it was found that date, burning and the time of herbicide application was significant. Average grass cover increased from 29.4% at the beginning of the study to 67.5% cover at the end. Burning increased the grass cover from 30.5% (unburned) to 42.2% (Fig. 5). All 3 times of application treatments had significantly different grass cover values with the June application highest (57.0), the October application intermediate (48.0), and the check lowest (28.5). There was little difference in grass cover between plots with burned and unburned palmettos receiving the October 2,4,5-T

Conclusions

Both burning and 2,4,5-T lowered TAC concentration and dry matter percentage of rhizomes of saw palmetto plants. Burning caused lower palmetto canopy cover and higher grass cover, and although there was a trend toward higher mortality if palmettos were burned in late February then sprayed with 2,4,5-T in June or October, it was not significant ($P<0.05$). After 1 year the June application of 2,4,5-T resulted in better mortality than the October application; however, after 2 years there was no difference in mortality.

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SRM Election Results

The Elections Committee Chairman, Wally Gallaher, along with Colorado Section members counted the ballots for new officers on Monday, December 6.

Elected officers are:

Second Vice President—**Ed A. McKinnon**
Directors 1983-1985—**Pat O. Currie**
David A. Fischbach

Present Directors S. Wesley Hyatt and F.E. Busby will leave the Board in February, 1983.

Ballots and tally sheets are retained in the Denver office for one year for review. Approximately 30% of the membership voted.