Succession Of Various Aquatic Plants After Treatment With Four Herbicides[1]

R. S. HESTAND and C. C. CARTER

Aquatic Botanists
Florida Game and Fresh Water Fish Commission
Eustis Fisheries Research Laboratory
Eustis, Florida 32726

ABSTRACT

Plant succession after treatment with four herbicides: Mono (dimethytridecylamine)oxide-7-oxabicyclo(2.2.1)heptane-2,3-dicarboxylic acid (TD-1874); Mono(N, N-dimethylalkylamine-7-oxabicyclo (2.2.1) heptane-2, 3-dicarboxylic acid (Hydrothol 191); Dihydroxy aluminum salt of 7-oxabicyclo(2.2.1)heptane-2,3-dicarboxylic acid (System E); and 6.7-dihydrodiphyrido(1,2-e; 2′. 1′-C) pyrazinediium dibromide (Diquat) plus triethanolamine complex of copper sulfate (Cutrine Plus) was evaluated in test pools in central Florida. Hydrothol 191 and TD-1874 rapidly killed coontail (*Ceratophyllum demersum* L.); muskgrass (*Chara* sp.); eelgrass (*Vallisneria americana* Michx.); hydrilla (*Hydrilla verticillata* Royle); Eurasian watermilfoil (*Myriophyllum spicatum* L.); and southern naiad (*Najas guadalupensis* (Sprengel) Magnus). However, hydrilla regrowth was recorded 28 and 40 days, respectively, after treatment and became the dominant plant 90 days following treatment. Diquat combined with Cutrine Plus resulted in a rapid kill and long term control, with eelgrass eventually becoming the dominant plant. With System E, a slow kill with long term control was evident with muskgrass becoming the dominant plant.

INTRODUCTION

The literature contains many references about the physiological effects of herbicides on plants (1, 3, 4, 5, 10, 11). However, little is known about the succession of aquatic plants after a herbicide application.

Aquatic plant succession after a drawdown or water level fluctuation has been well documented in the southeastern

[1]Paper number 30 of the Eustis Fisheries Research Laboratory, Florida Game and Fresh Water Fish Commission.

United States. Two years following a drawdown on a Central Florida lake, hydrilla became the dominant plant, replacing coontail, southern naiad, and Brazilian elodea (*Egeria densa* Plachon) which had been the dominant submerged plants (7). Eelgrass also increased after the drawdown.

An integrated program of water level fluctuation and herbicide applications in Louisiana eliminated Brazilian elodea, hydrilla, coontail, and muskgrass. These plants were succeeded by pondweed (*Potamogeton capillaceus* Poin.) and slender spikerush (*Eleocharis acicularis* (L.) R. &. S.) (8). Manning and Sanders (9) found that muskgrass and slender spikerush increased in lakes following water fluctuation in Louisiana.

The objectives of this study were to document the effect of four herbicides on several common aquatic plants and the succession that followed the herbicidal treatment. The pools were treated in August 1974 and observed through May 1975.

METHODS AND MATERIALS

Forty-five plastic pools (91 cm in depth by 366 cm in diameter) were filled with washed sand to a depth of 15 cm and each planted with the following aquatic macrophytes in equal amounts: hydrilla; Eurasian watermilfoil; muskgrass; eelgrass; southern naiad and coontail. These plants were allowed to establish for approximately 1 year.

Water levels were stabilized at 90 cm and continuously maintained through an irrigation system connected to the Eustis city water supply. Pools were selected at random for the various treatments. Applications (total volume) of the four herbicides were administered at the following rates: TD-1874[2], 3 mg per liter, replicated nine times; Hydrothol 191, 3 mg per liter, replicated seven times; System E, 0.93 kg/ha (3.3 mg per liter), replicated nine times; Diquat plus Cutrine Plus, 1 mg per liter and 0.33 mg per liter, respectively, replicated nine times; and the control replicated nine times.

Plants were observed each day after treatment for the 1st week; every other day for a week; then once a week for 2 weeks. By this time the maximum herbicide effects had been recorded, and observations were recorded bimonthly. The percent cover for each species was determined by using a ring which divided the surface area of the pool into ten quadrants. The ring was placed over the pool and the area covered by each species in each quadrant was estimated and totaled as a percent of the entire pool area. The total resulted in the percent cover for that species.

RESULTS AND DISCUSSION

Aquatic plant communities are generally multistoried, thus each species has the capability to obtain 100% cover. The pools were densely populated with aquatic plants before treatment. The average percent cover for each species was eelgrass 14%, southern naiad 26%, muskgrass 14%, coontail 4%, Eurasian watermilfoil 18%, and hydrilla 37%.

All plants were rapidly controlled with TD-1874, Hydrothol 191, and Diquat combined with Cutrine Plus. By the 9th day following treatment all of the plants settled to the bottom and the water turned dark and septic (2). System E resulted in a selective kill with the affected plants falling to the bottom 14 days after treatment. Muskgrass was not effected by this herbicide.

Eelgrass:

Regrowth of eelgrass was noted at 68 days following treatment with TD-1874, Hydrothol 191, and Diquat and Cutrine Plus but did not occur until 228 days after treatment with System E (Figure 1). Eelgrass exhibited a rapid recovery after the Diquat and Cutrine Plus treatment and the cover averaged more than 40% at the end of the study. In the control pools, eelgrass slowly expanded its coverage from an average of 12% to nearly 30% at the study's conclusion.

Southern Naiad:

The earliest regrowth of southern naiad was noted 68 days following treatment with TD-1874 and Hydrothol 191, 102 days with Diquat and Cutrine Plus and 145 days with System E (Figure 2).

By the end of the study (280 days) the percent cover of southern naiad in the pools treated with Hydrothol 191 and TD-1874 had surpassed its pretreatment averages (28 and 24%, respectively).

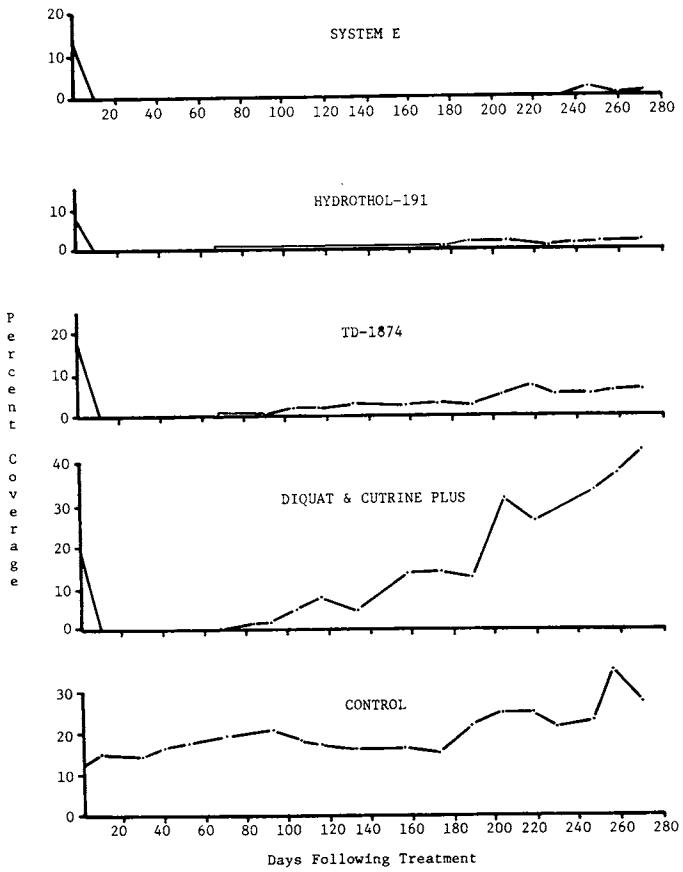

Figure 1. Succession of eelgrass for 280 days following treatment of aquatic plants in pools with various herbicides on 12 August 1974 (day 0).

[2]A coded experimental compound made by Pennwalt Corp.

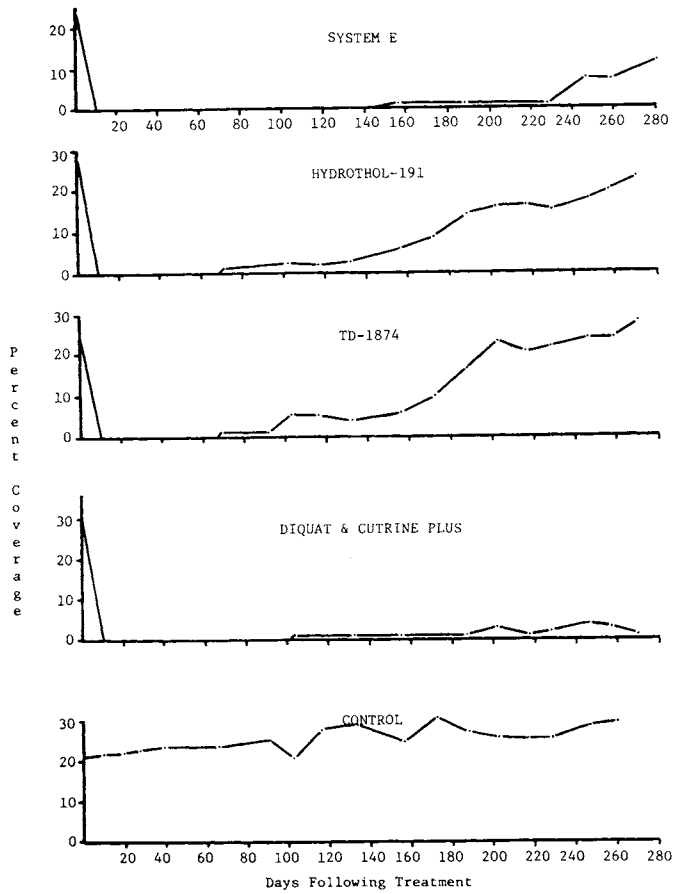

Figure 2. Succession of southern naiad for 280 days following treatment of aquatic plants in pools with various herbicides on 12 August 1974 (day 0).

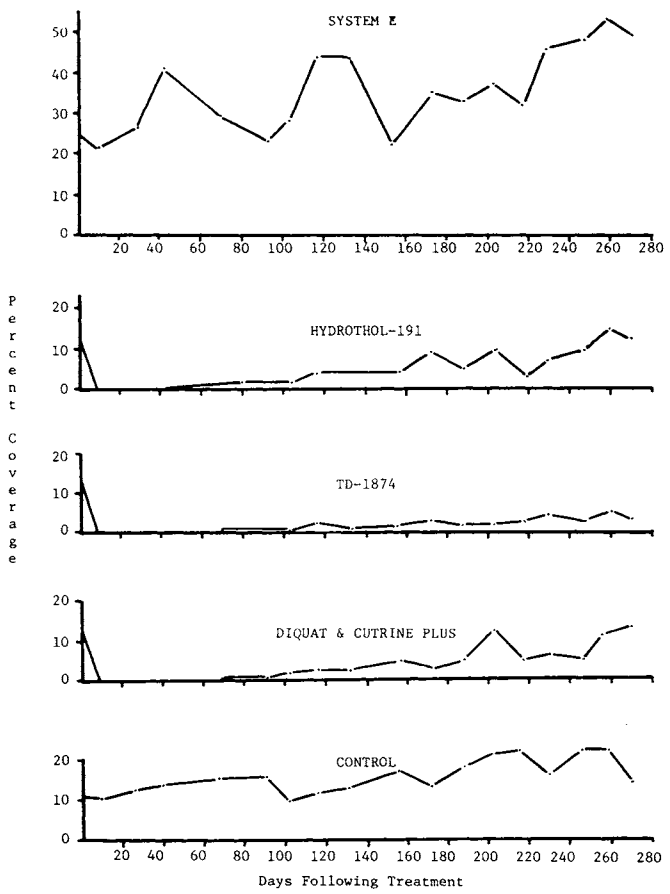

Figure 3. Succession of muskgrass for 280 days following treatment of aquatic plants in pools with various herbicides on 12 August 1974 (day 0).

Recovery of southern naiad was slow in the pools treated with System E but this plant was rapidly increasing at the conclusion of the study. Diquat and Cutrine Plus had a drastic effect on southern naiad and its percent cover was still less than 5% at 280 days after treatment. In the control pools the cover of southern naiad increased about 5% throughout the 280-day period (Figure 2).

Muskgrass:

After treatment with TD-1874 and Diquat combined with Cutrine Plus, regrowth of muskgrass appeared at 68 days. With Hydrothol 191 regrowth was noted at 42 days. System E did not effect the muskgrass as did the other herbicides (Figure 3). This herbicide killed the other plants and eliminated the competition. Muskgrass exhibited an accelerated growth rate for 40 days following treatment, nearly doubling its percent cover. It then vacillated throughout the rest of the study, and at 280 days had more than doubled its average percent cover for the pools treated with System E. In the pools treated with Hydrothol 191 and Diquat with Cutrine Plus, muskgrass recovered to its pretreatment percent cover by the end of the study.

The muskgrass in the control pools exhibited a general but erratic increase in percent cover throughout the study (Figure 3).

Coontail:

All of the herbicides eradicated coontail in the pools. This plant was not dominant in any of the pools (Figure 4). Its highest percent cover in the controls was very early in the study. It was evident that coontail could not compete with the other plants and generally declined in cover during the course of the study.

Eurasian watermilfoil:

Diquat with Cutrine Plus and Hydrothol 191 completely eliminated Eurasian watermilfoil (Figure 5). Regrowth of this plant was recorded 92 days following treatment with TD-1874. Its percent cover remained low until near the end of the study when it began an upward trend. Recovery with System E was very slow. Regrowth occurred at 102 days following treatment and the percent coverage remained at a very low level. In the control pools, Eurasian watermilfoil held rather constant in its percent coverage throughout the study (Figure 5).

Hydrilla:

This was the principal plant of concern due to its ability to quickly regenerate after herbicide treatments, and its explosive growth rate (7). With Hydrothol 191 and Diquat combined with Cutrine Plus regrowth of hydrilla was re-

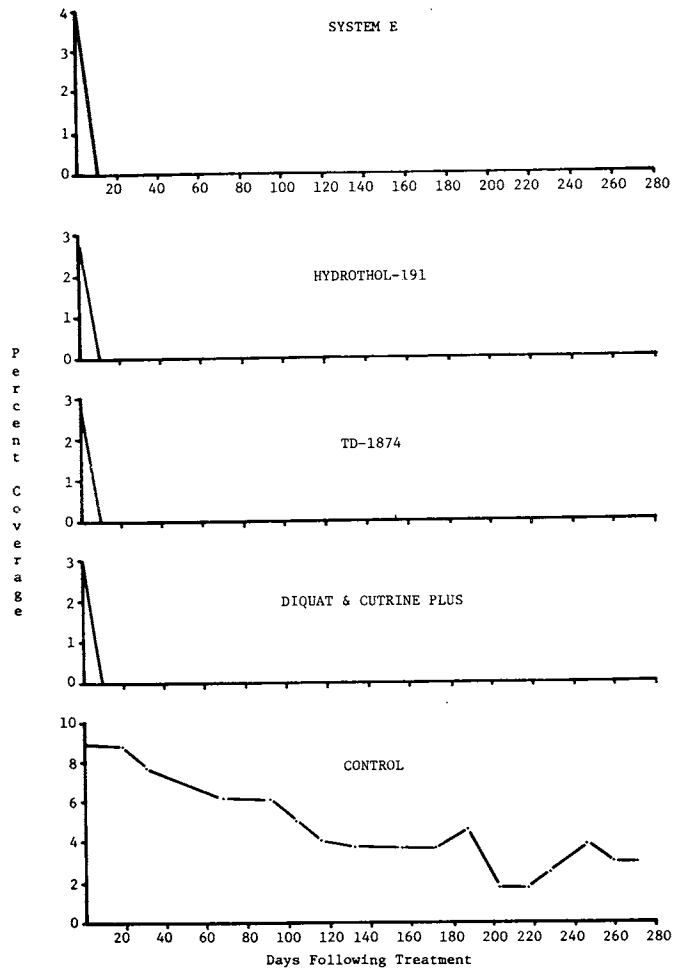

Figure 4. Succession of coontail for 280 days following treatment of aquatic plants in pools with various herbicides on 12 August 1974 (day 0).

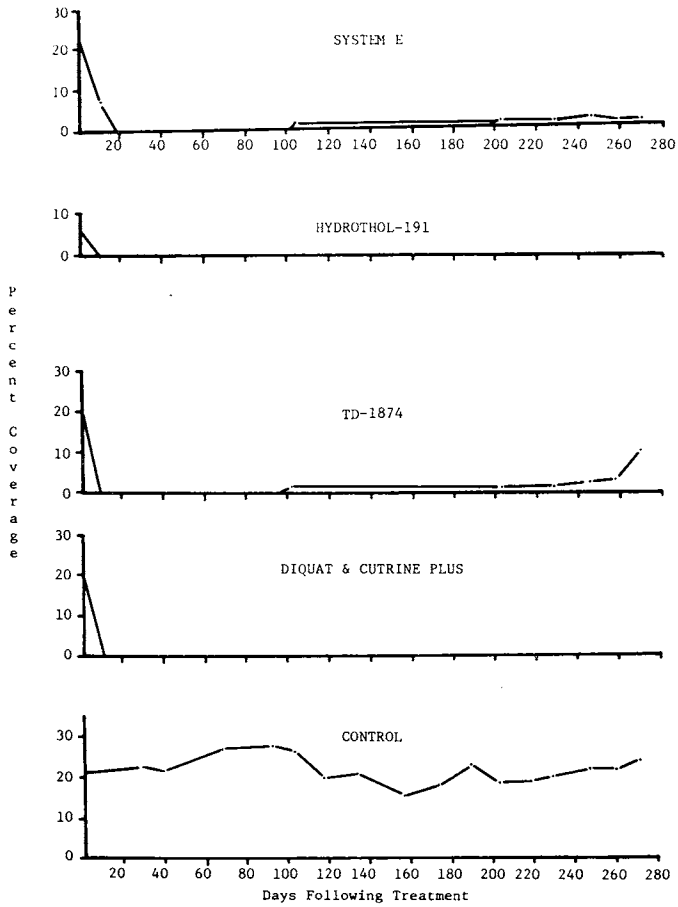

Figure 5. Succession of Eurasian watermilfoil for 280 days following treatment of aquatic plants in pools with various herbicides on 12 August 1974 (day 0).

corded 28 days following treatment (Figure 6). Regrowth was first recorded 40 days after treatment with TD-1874 and at 92 days with System E.

Hydrilla quickly became the dominant plant in the pools treated with Hydrothol 191 and TD-1874. The cover in the TD-1874 pools averaged over 30% within 100 days after treatment and continued to increase until the end of the study. With Hydrothol 191, hydrilla averaged 25% coverage within 90 days and continued to increase steadily thereafter. Hydrilla was favored by these two herbicides due to its quick recovery and establishment of a near monoculture by preventing other plants from becoming established.

When treated with Diquat combined with Cutrine Plus, hydrilla quickly reestablished but never dominated the pools. At the end of the study (280 days), the coverage of hydrilla was 35%, indicating it was out-competing the other plants present in the pools (Figure 6). Competition from other plants in a hydrilla community is limited due to the canopy it produces (6).

The hydrilla in the control pools grew until winter when it began to die back. At 240 days after treatment (April), it started to quickly recover the area it had lost during cool weather.

Two plants were successful in reestablishing dominance when treated with TD-1874: southern naiad and hydrilla. Coverage at the conclusion of the study was 30 and 70%, respectively. When Hydrothol 191 was used the same plants were successful, southern naiad at 25% and hydrilla at 75% cover.

Pools treated with System E and Diquat combined with Cutrine Plus resulted in different successional trends. With System E muskgrass was the dominant plant (50% cover) followed by southern naiad and hydrilla at 15% cover each. Diquat combined with Cutrine Plus resulted in eelgrass becoming dominant (50% cover) and hydrilla at 35% cover.

Thus treatment with the liquid endothal compounds resulted in pools dominated by hydrilla; System E resulted in domination by muskgrass; and Diquat with Cutrine Plus resulted in domination by eelgrass. Therefore, it seems possible to select a herbicide that could help to selectively manage the species composition in a body of water.

LITERATURE CITED

1. Audus, L. J. 1964. Physiology and biochemistry of herbicides. Acad. Press. London and New York. 555 pp.
2. Carter, C. C. and R. S. Hestand. 1977. The effects of selected herbicides on phytoplankton and sulfur bacteria populations. Aquatic Plant Management J. 15:47-56.

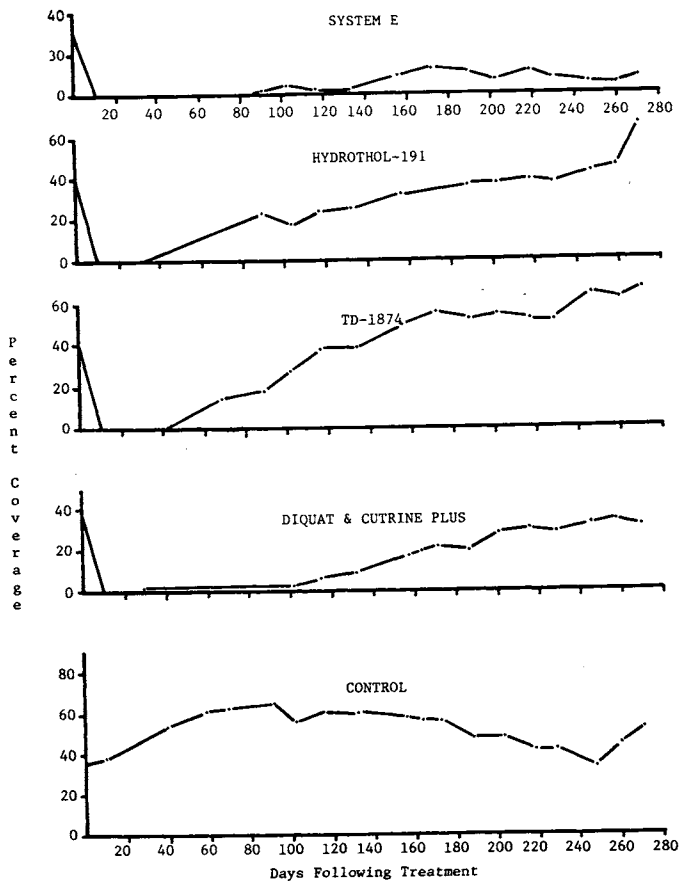

Figure 6. Succession of hydrilla for 280 days following treatment of aquatic plants in pools with various herbicides on 12 August 1974 (day 0).

3. Davies, P. J. and D. E. Seaman. 1968. Uptake and translocation of diquat in elodea. Weed Sci. 16:293-295.
4. Elliston, R. A. and K. K. Steward. 1972. The responses of Eurasian watermilfoil to various concentrations and exposure periods of 2,4-D. Hyacinth Contr. J. 10:38-40.
5. Haller, W. T. and D. L. Sutton. 1973. Factors affecting the uptake of endothall-14C by hydrilla. Weed Sci. 21:446-448.
6. Haller, W. T. and D. L. Sutton. 1975. Community structure and competition between hydrilla and vallisneria. Hyacinth Contr. J. 13:48-50.
7. Hestand, R. S. and C. C. Carter. 1975. Succession of aquatic vegetation in Lake Ocklawaha two growing seasons following a winter drawdown. Hyacinth Contr. J. 13:43-47.
8. Manning, J. H. and R. E. Johnson. 1975. Water level fluctuation and herbicide application: an integrated control method for hydrilla in a Louisiana reservoir. Hyacinth Contr. J. 13:11-17.
9. Manning, J. H. and D. R. Sanders. 1975. Effects of water level fluctuation on vegetation in Black Lake, Louisiana. Hyacinth Contr. J. 13:17-21.
10. Silver, W. S., R. L. Mansell, and J. A. Illingworth. 1974. Uptake of bivert-applied diquat by hydrilla. Hyacinth Contr. J. 12:30-34.
11. Sutton, D. L., W. T. Haller, K. K. Steward, and R. D. Blackburn. 1972. Effect of copper on uptake of diquat-^{14}C by hydrilla. Weed Sci. 20:581-583.