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Tractor dragging a chain-link fence over the plots to incorporate the herbicide into the soil

Efficacy of Sediment-Applied Herbicides Following Drawdown in Lake Ocklawaha, Florida

by
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Lake Ocklawaha is located about 40 kilometers southeast of Palatka, Florida (Figure 1). This reservoir was constructed as part of the Cross Florida Barge Canal in 1968 and covers approximately 4,200 hectares. Over the years, rapid encroachment of submersed aquatic plants, particularly hydrilla, has required intensive efforts to manage the vegetation using water-level fluctuations and chemical treatments. A series of drawdowns was conducted in Lake Ocklawaha from 1979 through 1983. Preliminary research results by the University of Florida suggested that these drawdowns improved hydrilla control and oxidation of exposed sediment. Consequently, the potential for oxygen depletion during the summer was thought to be reduced.

A winter drawdown of this reservoir of about 1.5 meters was initiated in December 1985 and by mid-January 1986 the desired elevation was achieved and maintained through April 1986. The drawdown was conducted to expose the sediment for drying and subsequent desiccation of all submersed vegetation, primarily to evaluate the effects of drawdown on sprouting of hydrilla tubers following refilling of the reservoir and to reduce the likelihood of a fish kill during the summer of 1986. This management option was an interim measure while a revised vegetation management plan was being developed.

Objectives

Winter drawdown provided the opportunity to evaluate selected chemicals at herbicidal rates--Casoron 10G, Oust, Sonar SRP, and controlled-release (CR) fluridone--when applied to the exposed sediment and to determine the plant growth regulator (PGR) characteristics of Casoron 10G and Oust at low application rates.

Approach

The four herbicide formulations and treatment rates selected for this study are given below.

Formulation	*Application Rate, Kilograms of Active Ingredient (ai) per Hectare*	*Plots*
Casoron 10G	1.5*	2, 6, 10
Casoron 10G	15	4, 8, 12
Sonar SRP	2.2	1, 11, 15
CR fluridone	2.2	7, 16, 20
CR fluridone	4.5	9, 18, 23
Oust	0.04*	5, 17, 21
Oust	0.09	14, 19, 24
Reference	--	3, 13, 22

* Rate used as plant growth regulator.

A completely randomized test plot design, with three replications, was followed using 12- by 24-meter plots with 24-meter buffer zones separating treated plots. Each plot was situated parallel to the shoreline along the lakeward face of Rodman Dam (Figure 1) to ensure complete inundation following closure of the outlet gates. A Gandy-type granular applicator and a backpack sprayer (Solo, Model 402) were used to apply the herbicides.

Following herbicide application, a tractor dragging a section of chain-link fence was used to incorporate the herbicides into the sandy bottom. Sediment samples were taken from three locations within selected plots (highest herbicide rate) for residue analysis immediately after treatment and 12 and 20 weeks posttreatment. Samples were analyzed for chemical residues by the Tennessee Valley Authority and the University of Florida using Environmental Protection Agency approved procedures and analytical techniques provided by the respective chemical companies.

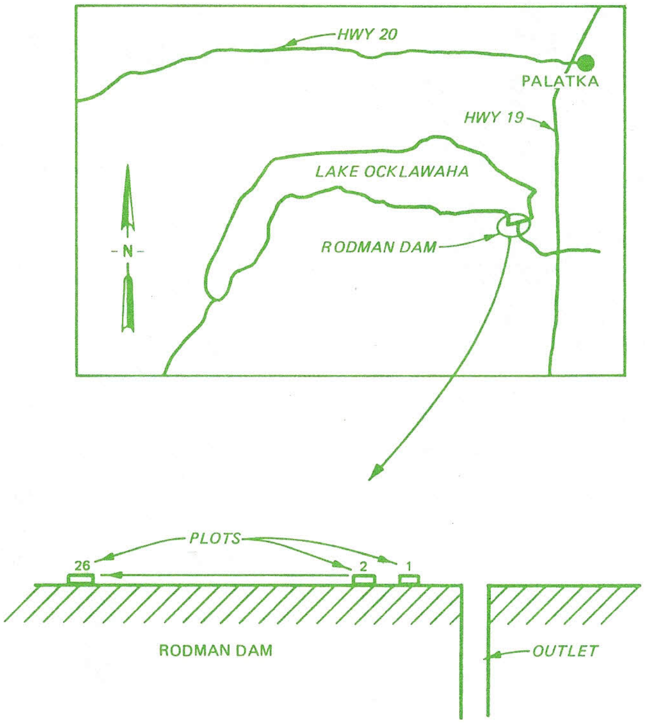

Figure 1. Site map of Lake Ocklawaha, Florida, and plot layout of Rodman Dam

Before drawdown the near-shore area was covered with hydrilla, which was dominant, and Illinois pondweed. At the time of treatment, there was no visible evidence of these plants remaining on the exposed sandy sediment. Following treatment, the sediment was covered by the lake water within 3 weeks. Regrowth was monitored at 9, 12, 20, 24, and 29 weeks posttreatment. Visual observations of percent regrowth and qualitative descriptions of herbicide effects on regrowth of aquatic plants were recorded.

Mode of Action

Casoron 10G

The major route of Casoron 10G (dichlobenil) uptake is through the roots, where it is translocated to the growing points of shoots and roots inhibiting cell division (Weed Science Society of America 1983). Casoron 10G is particularly effective at inhibiting the growth of germinated propagules. Shallow-rooted plants tend to be most susceptible to dichlobenil, because the herbicide does not readily move laterally or vertically through the sediment. The formulation used in this study was a 10 percent active ingredient granule.

Fluridone

Fluridone has been shown to be an effective

Application of liquid herbicides to sediment with a backpack sprayer following draw-down of Lake Ocklawaha

Granular herbicides applied using a Gandy-type spreader terrestrial and aquatic herbicide (Webster and others 1977, McCowen and others 1979, Sanders and Theriot 1979, and West and Parka 1981). The primary route of uptake is at the apical tips of shoots, followed by translocation down the shoot. This herbicide appears to inactivate biosynthesis of photosynthetic pigments (Bernard, Rainey, and Lin 1978), namely carotenoids, and causes bleaching of chlorophyll (Krinsky 1967). The Sonar SRP formulation is a slow-release pellet formulation which is designed to release the herbicide over several days, depending on the rate of pellet exfoliation and hydrodynamics. The CR fluridone was a "pelleted" polymer fiber formulation developed under contract with Southern Research Institute, Birmingham, Alabama, and engineered to release fluridone over a 20- to 30-day period (Dunn and others 1988).

Oust

The common chemical name of Oust is sulfometuron methyl. Sulfometuron methyl is a powerful and rapid inhibitor of plant cell division. Other plant functions such as cell elongation or expansion, photosynthesis, and respiration remain unaffected. In most sediment environments, sulfometuron methyl may be absorbed through the roots and translocated to the apical tips. The formulation used in this study was a wettable powder.

Results and Discussion

Figures 2 through 4 represent the mean percent regrowth (±1 standard error) of aquatic vegetation throughout each plot, including regrowth from reproductive propagules (hydrilla tubers) and reinfestation from plant fragments outside the treated areas.

Reference plots

The reference plots (plots 3, 13, and 22) exhibited pronounced regrowth of hydrilla and Illinois pondweed following refilling of the reservoir through 12 weeks posttreatment. The young hydrilla at 9 and 12 weeks after treatment were prostrate on the sediment with very few erect shoots, but the pondweed was near the water surface and flowering. At 24 weeks posttreatment, the plots were covered primarily with pondweed and only small clusters of hydrilla, which were scattered throughout the plots. Plant injury, including absence of standing vegetation, from weeks 24 through 29 posttreatment was primarily evident in plot 13. This reference plot was between an Oust-treated (plot 14) and a Casoron 10G-treated plot (plot 12). The general waterflow toward the dam outlet may have carried the Oust from plot 14 through the buffer area to plot 13 (Figure 1), where it injured the vegetation. If Oust is considered for aquatic use registration, its release from the sediment to overlying water should be closely evaluated.

Casoron 10G plots

The three plots treated with dichlobenil (plots 4, 8, and 12) at the recommended herbicidal rate of 15 kilograms ai per hectare exhibited acceptable regrowth suppression (greater than 80 percent) for a minimum of 20 weeks (Figure 2). At 29 weeks posttreatment, hydrilla and pondweed were well established throughout the treated plots, but vertical growth remained lower than the untreated reference plots. Of the three replicates--plots 2, 6, and 10--vegetative growth inhibition was greater than 80 percent in plots 6 and 10 through week 20. In plot 2, no plant inhibition was evident. The proximity of plot 2 to the dam outlet and continuous waterflow out of the reservoir may have resulted in a lower than necessary herbicide concentration or a plant exposure time that was too short to achieve efficacy.

The low application rate (1.5 kilograms ai per hectare) was effective in maintaining regrowth of hydrilla and pondweed at a 60 to 70 percent regrowth through 29 weeks posttreatment (Figure 2). Though plants remained short throughout the study period, hydrilla and pondweed remained very short compared to plant growth outside the treatment area including the reference plots.

Detectable herbicide residues in sediment were measured through 20 weeks posttreatment from plots 4 and 12; measurements were 0.06 and 0.28 micrograms ai per liter, respectively, at 20 weeks posttreatment. Subsequent retreatment of dichlobenil to the previously treated water column in one growing season may result in an accumulation of residues from one year to the next. A closer examination of herbicide persistence in sediment is necessary prior to modifying current use restrictions.

Fluridone plots

Of the two fluridone formulations used, the CR formulations provided the longest suppression of plant regrowth--up to 24 weeks posttreatment (Figure 3). These formulations maintained approximately 60 to 70 percent regrowth control of hydrilla and pondweed for 29 weeks. At 20 weeks posttreatment, plants were present as very short, erect plants scattered throughout the plots. By 24 weeks posttreatment, plants were scattered throughout the plots and were near the water sur-

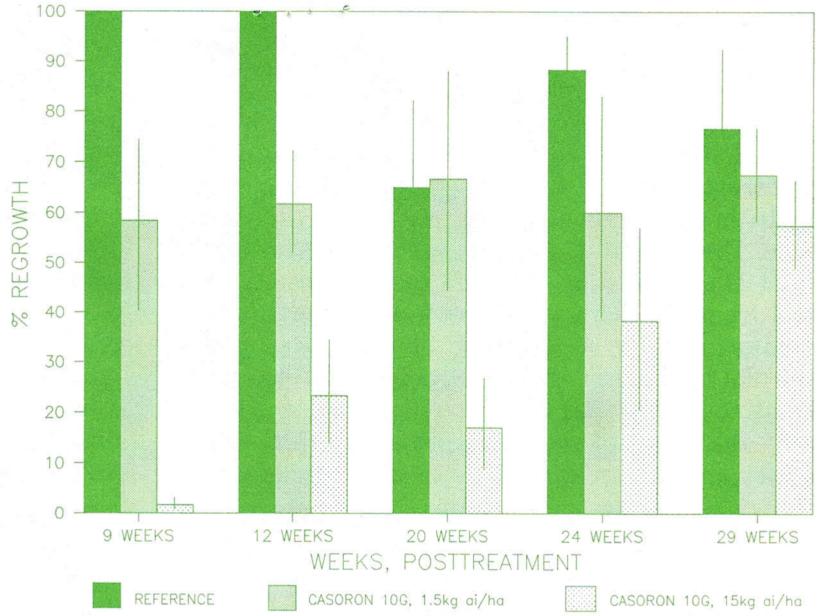

Figure 2. Percent regrowth control of submersed vegetation following treatment with two rates of Casoron 10G

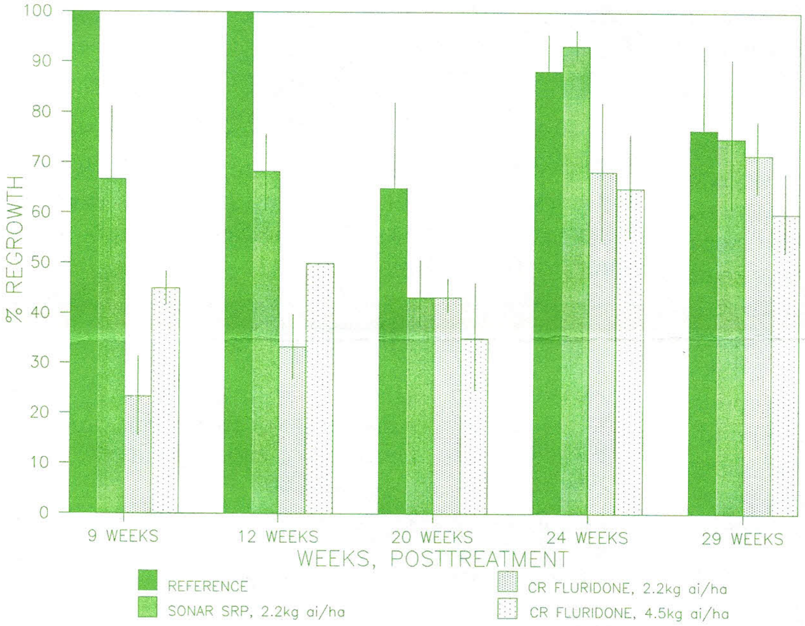

Figure 3. Percent regrowth control of submersed vegetation following treatment with Sonar SRP and experimental CR formulations

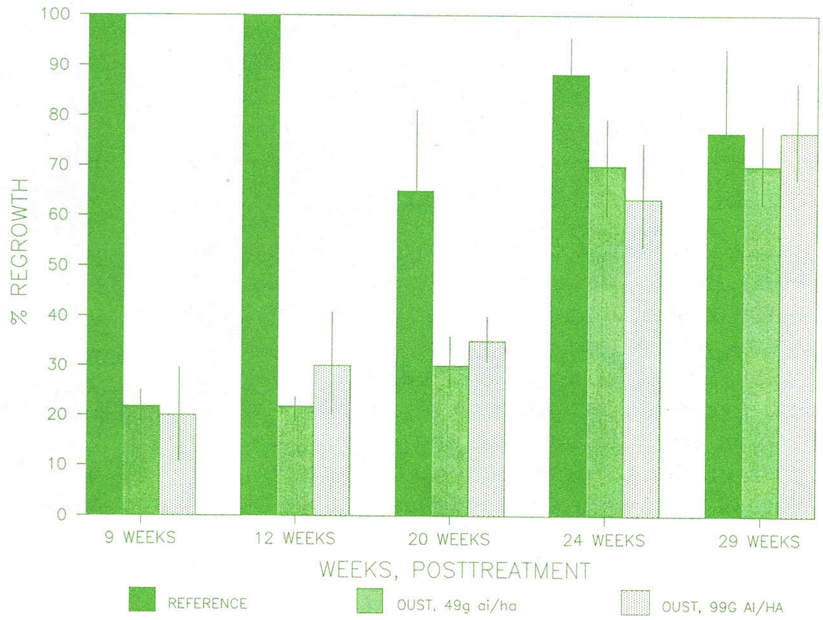

Figure 4. Percent regrowth control of submersed vegetation following treatment with two rates of Oust

face. By 29 weeks posttreatment, hydrilla and pondweed had grown to the water surface throughout the treated plots.

The Sonar SRP formulation influenced the rate of hydrilla and pondweed regrowth for 20 weeks posttreatment, and by 24 weeks posttreatment the hydrilla and pondweed had grown to the water surface. The treated plot closest to the reservoir outlet (plot 1) exhibited no effect on plant regrowth control from the Sonar SRP treatment. Hydrilla and potamogeton were growing actively throughout the plot by the first evaluation period--9 weeks posttreatment. This lack of regrowth control was probably the result of the plot's proximity to the dam outlet and waterflow, as previously discussed.

Low levels of sediment residues immediately after treatment ranged from 10 to 30 micrograms ai per kilogram in all six plots, and 12 weeks later all residues were below detection (less than 10 micrograms ai per kilogram). These levels are only 1 to 3 times greater than detection limits.

Oust plots

The Oust formulation provided consistent regrowth control of submersed and emergent aquatic plants for 20 weeks following treatment (Figure 4). Through 12 weeks following treatment only 20 to 30 percent of each plot area contained a few scattered shoots of hydrilla and pondweed. There were no observable differences in efficacy between the two application rates. By 24 weeks posttreatment, the surface areas of some plots were covered with erect, healthy hydrilla and pondweed. Emergent vegetation was not present along the shoreline throughout the study of all six plots, but was present in the reference and other treated plots. After 29 weeks, scattered emergent vegetation was observed only along the shoreline of the Oust plots.

Sediment residues ranged from 0 to 10 micrograms ai per kilogram immediately posttreatment and were below detection after 12 weeks in all of the treated plots.

Conclusions

Based on results of this study, herbicide application during drawdown conditions to control regrowth of submersed aquatic plants is feasible and recommended. Reproductive propagules and fragments of hydrilla, pondweed, and miscellaneous grasses are effectively controlled when Casoron 10G, CR fluridone, and Oust are incorporated in the air-dried sediment. Moreover, evidence of plant control beyond the fluridone-treated area was not apparent, suggesting that fluridone "drift" is not significant when it is incorporated in the sediment directly. Oust should be tested at lower rates under similar conditions to determine the cost-effective, lowest rate which suppresses regrowth.

Casoron 10G, at the high rate, was the most effective in suppressing plant regrowth. Since the herbicide is persistent (effective for greater than 24 weeks) in this sandy sediment, the potential for sediment accumulation exists. Reapplication during the growing season is not recommended. However, the current water-use restrictions (90 days) must be reduced before this product can be used extensively.

The use of plant growth regulating chemicals, such as Oust and Casoron 10G, at low rates to slow vertical growth from reproductive propagules and plant fragments as well as lateral spread from nodes and rhizomes offers the potential for managing nuisance aquatic plants.

Acknowledgements

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23rd Annual Meeting

The 23rd Annual Meeting and Program Review of the US Army Corps of Engineers' Aquatic Plant Control Research Program will be held at The Palm Hotel in West Palm Beach, FL, 14-17 November 1988. A block of rooms has been reserved at $56.00 single and $60.00 double occupancy plus tax. Reservations must be made before 24 October 1988 in order to receive these reduced rates.

On Wednesday, 16 November, a morning session will be devoted to Lake Okeechobee, followed by a field trip to the lake in the afternoon. Airboats will be available to provide a tour of the lake to view the aquatic plants and related problems. A dinner cruise on the lake will follow the airboat tours at a cost of $20.00 per person payable at registration.

The point of contact for more information is Ms. Billie Skinner, (601) 634-3701.

Request for Articles

Articles for the *Aquatic Plant Control Research Program* Bulletin are currently being solicited. If you have information concerning aquatic plant control research, please write Lewis Decell describing your work or send completed articles for consideration. Articles should run about 1,000 to 1,500 words and several black-and-white or color photographs (or slides) should be included. Address articles to Environmental Laboratory, ATTN: CEWES-EP-A, US Army Engineer Waterways Experiment Station, PO Box 631, Vicksburg, MS 39181-0631.

AQUATIC PLANT CONTROL RESEARCH PROGRAM

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DWAYNE G. LEE
Colonel, Corps of Engineers
Commander and Director

Four different herbicides (Casoron 10G, Sonar SRP, CR Fluridone and Oust) were applied at different treatment rates to test their efficacy following a winter drawdown of Lake Ocklawaha, Florida. Results of the study indicated that herbicide application during drawdown conditions to control regrowth of submersed aquatic plants is feasible.

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