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Chemical Control Research in the Corps of Engineers

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ABSTRACT

Research and development activities in the Corps of Engineers chemical control technology area concentrate on evaluating chemical products and developing application techniques that will improve the management of exotic and nuisance aquatic plants. Current research efforts are focusing on species-selective control of target plants, precision herbicide application techniques, and integration of control strategies with ecological principles. Studies are conducted in controlled-environment chambers, greenhouses, hydraulic flumes, outdoor mesocosms, experimental ponds, and in the field. Cooperators and partners include Federal, state and local agencies, Corps of Engineer Districts, academic institutions, and the private sector. Interactions also occur with Federal and state regulatory agencies. Proven benefits derived from this chemical control research effort include lower herbicide use rates, improved environmental compatibility, and reduced application costs.

Key words: aquatic herbicides, aquatic plant management, Eurasian watermilfoil, hydrilla, nuisance exotics, species-selective control.

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INTRODUCTION

When used according to label directions and in a responsible manner, aquatic herbicides are a consistently effective technique for managing nuisance vegetation. In addition, they are economical, environmentally compatible, and safe to use. These traits can make chemical control the method of choice for many aquatic plant management situations. Over the past 10 to 15 years, herbicide use patterns have been maintained, or have increased, in many states infested with exotic aquatic plant species. For example, annual chemical treatments against waterhyacinth (*Eichhornia crassipes* (Mart.) Solms) and hydrilla (*Hydrilla verticillata* Royle) have routinely been used in Florida public waters since 1982 to control 12,000 to 16,000 ha of these plants per annum (Figure 1). In Minnesota, the annual use of selected herbicides in public waters has coincided with the establishment and spread of Eurasian watermilfoil (*Myriophyllum spicatum* L.) in that state, increasing almost 10-fold, from approximately 4,500 kg in 1987 to over 45,000 kg in 1995 (Figure 2). Although herbicides currently play a prominent role in managing aquatic vegetation, improved and innovative uses of these products, new formulations, low-dose application techniques, and species-selective treatment strategies, are directly linked to research and development (R&D) activities. This paper provides an overview of the chemical control R&D efforts, facilities, and capabilities associated with the US

Army Corps of Engineers (CE) Aquatic Plant Control Research Program (APCRP). Furthermore, a brief summary of the three Federally-funded work units in this technology area will be presented.

WES CHEMICAL CONTROL TECHNOLOGY TEAM

The CE's APCRP sponsors R&D efforts with aquatic herbicides via the Chemical Control Technology Team (CCTT) at the US Army Engineer Waterways Experiment Station (WES) in Vicksburg, MS. The mission of the CCTT is to evaluate herbicides and develop application techniques for the selective management of exotic and nuisance aquatic vegetation. Practical benefits recently derived from the implementation of this mission include the operational transition to low herbicide use rates, improved environmental compatibility of chemical products and application techniques, improved selectivity to restore native plant communities, and reduced application costs.

Assisting the CCTT in this national R&D effort are several CE Districts such as Baltimore, Jacksonville, Mobile, and Seattle, and Federal Agencies such as the US Department of Agriculture (USDA), the Tennessee Valley Authority (TVA), and the US Bureau of Reclamation (USBR). In addition, state natural resource agencies such as the Alabama Department of Conservation and Natural Resources, the Florida Department of Environmental Protection, the Michigan Department of Environmental Quality, the Minnesota Department of Natural Resources, the South Carolina Department of Natural Resources, Texas Parks and Wildlife Department, and the Washington Department of Ecology cooperate with the CCTT. Finally, academic institutions such as the University of Florida, Purdue University, North Carolina State University, Mississippi State University, and the University of California-Davis, and elements of the private sector such as chemical companies and the Aquatic Ecosystem Restoration Foundation partner with the CCTT. The CCTT also chairs the Federal Aquatic Herbicide Working Group (CE, USBR, USDA, TVA) which interacts closely with the US Environmental Protection Agency (USEPA) Office of Pesticide Programs and various state regulatory agencies to discuss and review aquatic pesticide use and registration issues (Getsinger 1995).

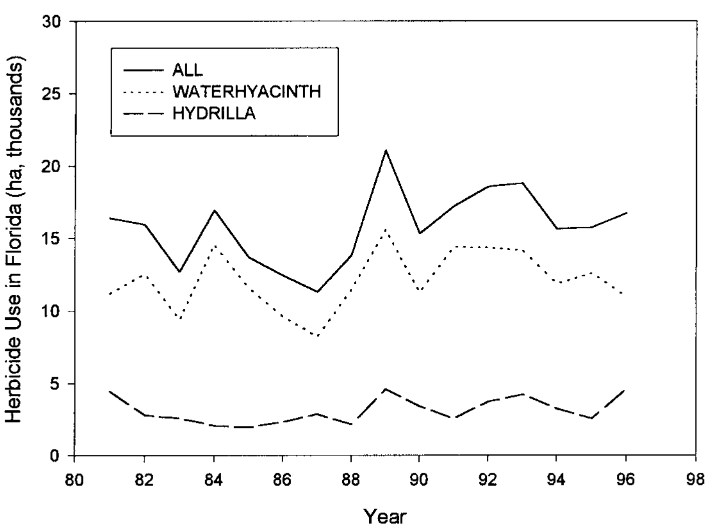

Figure 1. Annual aquatic herbicide use in Florida, 1980-1996. Data provided by the Florida Department of Environmental Protection.

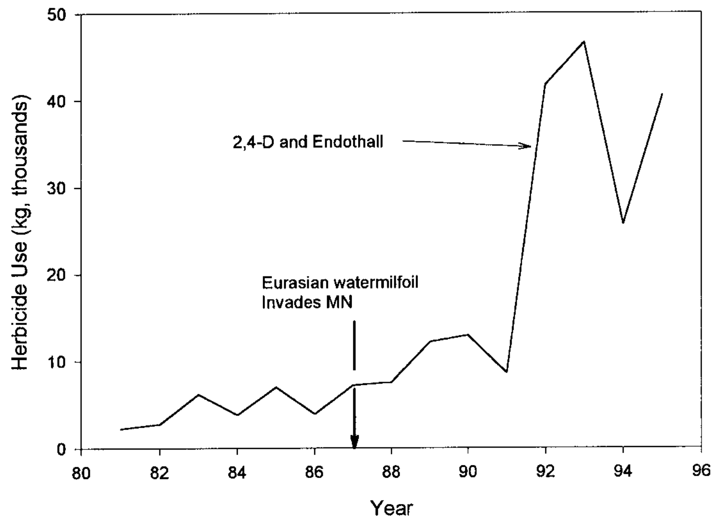

Figure 2. Annual use of the aquatic herbicides 2,4-D and endothall, for controlling Eurasian watermilfoil in Minnesota, 1981-1995. Data provided by the Minnesota Department of Natural Resources.

The CCTT conducts research at multi-scale levels in facilities that range from laboratory and controlled-environment chambers at WES to greenhouses, large outdoor mesocosms and ponds at the Lewisville Aquatic Ecosystem Research Facility (LAERF) in Texas, culminating with field verification studies conducted in waterways throughout the U.S. By leveraging resources with the sponsors and cooperators noted above, extended lines of research have been possible, leading to major advances in aquatic herbicide technology.

BENEFITS OF CCTT RESEARCH EFFORTS

One prominent example of the benefits derived from a coordinated and sustained R&D strategy involves the improved use of the herbicide fluridone (1-methyl-3-phenyl-5-[-3(trifluoromethyl)phenyl]-4(*1H*)-pyridinone) for controlling hydrilla and Eurasian watermilfoil. In 1986, fluridone received a national aquatic registration (Section 3) from the USEPA, with great promise as a new aquatic plant management tool. Although the product was being applied at the high end of its legal use-rate range (90 to 150 µg/L) in 1986, target plant efficacy was unpredictable, erratic, and non-selective in many situations, and treatments were costly. By 1993, combined R&D efforts had fine-tuned use rates down to 15 to 20 µg/L, target plant efficacy was predictable and consistent in static water conditions, and inroads into improving efficacy in flowing water were well underway. At present, further research findings have resulted in operational use rates declining to 5-10 µg/L (a > 10-fold decrease from earlier times), while achieving predictable, consistent, species-selective, and low-cost, weed control.

The CCTT has also led a major effort in pursuing a Section 3 aquatic label for the compound triclopyr (3,5,6-trichloro-2-pyridinyl-oxyacetic acid) (Petty et al. 1997a, 1997b, 1997c); which, if registered next year, will be the first aquatic label for a new chemistry in over a decade. In addition, a CCTT-directed R&D coalition evaluated and developed a new superabsorbent polymer carrier for the herbicide endothall (7-oxabicyclo(2.2.1)heptane-2,3-dicarboxylic acid) (Netherland et al. 1998). Once registered, this innovative granular concept will greatly improve the safety factor involved in applicator handling as well as streamline the field application process of this herbicide.

CHEMICAL CONTROL TECHNOLOGY WORK UNITS

In fiscal year 1997 (FY97), direct allotted funds under the APCRP for chemical control R&D were divided between two work units: (a) Herbicide Delivery Systems; and (b) Species-Selective Use of Aquatic Herbicides and Plant Growth Regulators (PGRs). One additional work unit, Integrated Use of Herbicides and Pathogens for Submersed Plant Control, was also under the direction of the CCTT during FY97. Detailed updates of each work unit can be found in other articles in these proceedings (Nelson et al. 1998, Sprecher et al. 1998, Sisneros et al. 1998).

Herbicide Delivery Systems

Information generated in this work unit is used to design systems and/or techniques that can deliver low doses of herbicides over extended periods of time, while providing acceptable target plant control. Environmentally compatible controlled-release carriers, such as polymers, gypsum, proteins, etc., are evaluated for herbicide release rates and efficacy in small-scale systems at the WES. The most promising formulations are further evaluated in large-scale mesocosms and ponds at the LAERF. Results from these studies are used to improve the control of nuisance submersed plants, particularly in areas of high water exchange. Recent work has focused on endothall-polymer formulations and a low-dose metering technology (Netherland and Turner 1995, Sisneros and Turner 1996, Netherland et al. 1998).

Species-Selective Use of Aquatic Herbicides and PGRs

While weedy submersed species can be removed using traditional chemical control tactics, these treatments can negatively impact desirable native plant species. However, using chemicals in a species-selective manner (e.g., rate, timing, placement, etc.) can result in the control of target vegetation while enhancing the growth of desirable, beneficial plants by removing weedy competitors. Allowing desirable species to flourish can slow the reinvasion of weedy species and provide improved fish and wildlife habitat. In this way, water bodies plagued with monospecific infestations of exotic plants can be managed to provide a more healthy, diversified, and ecologically-balanced aquatic community. Recent selectivity efforts have evaluated triclopyr (Smart et al. 1995, Getsinger et al. 1997), fluridone (Netherland et al. 1997), and 2,4-D (2,4-dichlorophenoxy acetic acid) (Sprecher et al. 1998).

Integrated Use of Herbicides and Pathogens for Submersed Plant Control

One potential method for reducing herbicide rates while maintaining or improving target plant control is to integrate chemical treatments with known endemic plant-specific pathogens. By combining the strengths of a chemical treatment with a biological organism, the weaknesses of either control technique are often minimized or negated. Potential uses of herbicide/pathogen combinations include: (1) using low rates of herbicide to stress target plants, making them more susceptible to pathogenic attack, and (2) use of pathogens as contact bioherbicides to reduce standing biomass of target plants followed by reduced rates of herbicides to eliminate regrowth or extend efficacy. Selected aquatic herbicide and pathogen combinations are being evaluated for synergistic and/or antagonistic relationships in growth chamber and outdoor mesocosm systems (Netherland and Shearer 1996, Nelson et al. 1998). Promising combinations will be further evaluated in ponds at the LAERF and/or other geographical locations. Results from this work will provide information on the potential of integrating chemical and biological control techniques to improve management of aquatic vegetation.

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