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Research Report No. 25

THE CONTROL OF AQUATIC AND MARGINAL WEEDS
Notes and Abstracts
From the 7th Annual Meeting of the Weed Science Society of America

By

Leon D. Johnson

WISCONSIN CONSERVATION DEPARTMENT

Research and Planning Division

July, 1967

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INTRODUCTION

This report consists of notes on the highlights of the 7th annual meeting of the Weed Society of America, held February 13 to 17, 1967 in Washington D. C. A total of 244 papers were presented during four concurrent sessions. Included are consolidated abstracts of 20 papers that were presented at that meeting on "the control of aquatic and marginal weeds."

In addition, an afternoon lecture tour was arranged to the USDA Plant Industry Station at Bellsville, Maryland. Brief notes on the work in progress there are also included in this report.

NOTES

Herbicides

There are 130 registered herbicides now. Only two of these have tolerance limits set for the amount of residue permitted in foods. All others are registered on a no residue basis. The common herbicide 2,4-D is one of these where a zero amount is allowed in foods. No herbicides are allowed in drinking water.

There are 3,500 research scientists working on herbicides and weed control and 30,000 working on pesticide applicators. Research has been aimed at determining the ways in which these chemicals work. A shortage of personnel exists in herbicides research and the universities are not now training people along these lines.

The economic importance of herbicides is increasing. During the past year herbicides made up one-third of the monetary value of all agricultural chemicals sold. Many companies wish to get in on this bonanza. The Morton Salt Company, Minnesota Mining and others are starting their own screening programs.

No important developments were made in the control of aquatic vegetation during 1966. There is almost no work at present in aquatic weed control because of the lesser monetary return to the manufacturer and the lack of importance for our food production.

Biological Controls

Biological controls of aquatic vegetation have been partially successful but not practical. In Florida, manatee and Marissa snails were used to eat vegetation in canals. The manatee died when confined solely to fresh water; the snails cannot tolerate cold water temperatures and therefore could not be used in northern waters. Both animals polluted the water, increasing turbidity with their metabolic waste products. Grass carp (not a Cyprinus) eats any kind of weed but is allowed in only a few ponds in Florida. In parts of Maryland Eurasian water milfoil (Mriophyllum spicatum) has a disease. Investigators are now trying to discover the causative agent in the hope that this disease may possibly be used for milfoil control.

USDA Plant Industry Station

The United States Department of Agriculture Plant Industry Station, Maryland, covers 10,000 acres and has 2,600 employees. Here, specialists from all disciplines are working on herbicides and their mechanisms of action. The laboratories have six acres of greenhouses and are equipped with the most modern instruments for synthesizing herbicides and analysing both vegetation and water for their presence.

One demonstration given was on partial herbicides (those that kill only specific parts of the plants). These were used for debudding greenhouse flowers. For example, one was used to kill all of the younger lateral buds on chrysanthemums allowing the twelve hour older terminal buds to grow. This technique produces larger flowers. Aromatic hydrocarbons with 8 to 12 carbon chains were used. The USDA laboratory was not working on pine trees but this herbicide debudding technique might be worked out to the benefit of Wisconsin Christmas tree growers, replacing laborious hand shearing or hand debudding.

ABSTRACTS

A Study of Additives to the Aqueous Phase of Aerially Applied Invert Emulsions.
J. H. Kirch and J. E. Esposito, Emchem Products, Inc., Ambler, Pennsylvania

Volatility and drift have been two serious problems connected with large scale applications of 2,4-D/2, 4,5-T and related compounds, particularly on utility rights-of-way. The introduction of low volatile esters and invert emulsions has contributed greatly to the solution of these problems.

Two tanks are required for the spraying. One filled with the herbicide the other filled with the invert. The two chemicals are mixed at the special spray nozzle and combine to form a plastic droplet somewhat the consistency of mayonnaise (which is also an invert emulsion). The droplets do not drift, and they adhere to the leaves of surface plants.

Characteristics of Thickened Sprays from Fixed Wing Aircraft.
S. K. Lehman, R. H. Haas, and L. F. Bouse, Texas Agr. Exp. Sta. and CPERB, AERD, ARS, USDA, College Station, Texas

Studies have been conducted to describe the droplet size and spray distribution characteristics of several thickened sprays used in the construction of fixed-wing aircraft. Invert emulsions applied with the bifluid system, a water-swellable polymer or "participating" agent, and hydroxyethyl cellulose were evaluated. Sprays of the above materials were compared with water and oil-in-water sprays.

Results of the research show that thickened sprays may provide varying degrees of drift control depending on factors such as nozzle tip design, nozzle orientation, and solution viscosity. Thickened sprays have produced a wide range of droplet sizes which includes significant numbers of large droplets.

Control of Reed Canary Grass Along Irrigation Canals. J. M. Hodgson, CRD, ARS, USDA, and Montana Agriculture Experiment Station, Bozeman, Montana

Reed canary grass (Phalaria arundinacea L.) is a perennial forage grass that is very aggressive on wet sites. It has invaded many ditchbanks, especially along the waterline where it seems to find nearly ideal conditions for growth. It collects silt, causes the canals to become narrow, and impedes the water delivery in irrigation canals.

Evaluation of chemicals for control of reed canary grass on ditchbanks has been in progress for several years. Repeated treatments with dalapon (2,2, dichloropropionic acid) or amitrole-T (3-amino, 1,2,4-triazole, ammonium thiocyanate) have given satisfactory control. Amitrole-T is generally the favored treatment because it is less toxic to certain short fine-stemmed grasses which form a desirable cover on ditchbanks.

In the past 2 years combinations of amitrole-T and several other chemicals have been tested. The most promising combination treatments included amitrole-T with dalapon, with TCA (trichloroacetic acid) or with pyriclor (2,3,5-trichloropyridinol). Amitrole-T at 2 lb./A and dalapon at 5 or 10 lb/A gave control of reed canary grass about equal to amitrole-T at 4 lb/A. The combination of amitrole-T and TCA at the same rates was also effective but not so consistent as dalapon and amitrole-T.

In 1964 and 1965, late fall or early winter treatments with TCA or dalapon at 20-40 or 80 lb/A gave excellent control of reed canary grass. Even at the lowest rate, reed canary grass was controlled through most of the following season. Toxic effects of TCA seemed depleted by mid-July of the following season, as indicated by the establishment of reed canary grass seedlings and regrowth from old roots.

Submersed Aquatic Weed Control in an Irrigation System with Acrolein.

V. F. Bruns, CRD, ARS, USDA, Prosser, Washington with the Bureau of Reclamation, U. S. Department of the Interior, and Washington State University cooperating.

The east Low Canal, Columbia Basin Project, with an average waterflow of 2,000 cfs at point of introduction, was treated six times per season in 1964 and 1965 with acrolein at 0.1 ppmw. Each treatment was 48 hours long. The first treatments each spring were made on May 18 when the maximum length of pondweeds was 6 to 10 inches. Retreatments were made when recovery of the pondweeds became obvious or when the maximum length of new growth was 4 to 8 inches. The intervals between treatments were about 3 weeks in May, June, and July and about 4 weeks in August and September. Water temperatures ranged from 46 F in mid-April to 74 F in early-August.

The pondweeds, sago (Potamogeton pectinatus L.), leafy (P. foliosus Raf.) and horned (Zannichellia palustris L.) as well as numerous species of algae were effectively suppressed throughout the season by the acrolein treatments.

Acrolein requires special pressurized tanks and under water nozzles for application. Personnel must use gas masks. It has been used experimentally in Wisconsin, but its use is not recommended.

An Economical Control Method for Vegetation in Drainage Canals.

V. T. Lapham, Louisiana Wildlife and Fisheries Com., Baton Rouge, Louisiana.

An extensive network of drainage canals has been constructed in East Baton Rouge Parish to protect housing developments and industrial sites from flooding during periods of heavy rainfall.

These canals furnish near optimum growing conditions for willow, Salix nigra; ragweed, Ambrosia sp.; elderberry Sambucus sp.; cattail, Typha sp.; alligatorweed, Alternanthera philoxeroides and others. Steeply sloped banks make mechanical removal difficult or impossible. Hand removal is slow, difficult and has little lasting effect.

Combinations of either silvex or picloram and any of several organic arsenical compounds have been used to maintain a vegetative cover of Bermuda grass, Cynodon dactylon, yet effectively remove undesirable vegetation from marginal areas of farm ponds. Cost was \$10.00 per acre. Surfactant X77 improved the wetting of leaves by the herbicides. DMSO (dimethyl sulfoxide) from Robbins M. Kesson at 1 to 2% by volume speeded translocation of the herbicides within the treated plants.

Eradication of Curlyleaf Pondweed from Mansion Pond. Robert C. Hiltibran, Illinois Natural History Survey, Urbana, Illinois

Two stands of curlyleaf pondweed were removed each year during 1960, 1961 and 1962, using primarily granular or liquid endothall (7-oxabicyclo (2.2.1) heptane-2, 3-dicarboxylic acid) at a rate of 1 ppm. During 1963 and 1964 widely scattered curlyleaf pondweed plants were observed and these were treated with granular endothall.

Chara, Chara sp., became the most abundant vegetation and herbicides for the removal of the existing stands of chara and filamentous algae were applied in 1964, 1965 and 1966.

All applications of herbicides were made prior to seed production. Water temperatures should be 60°F for effective application, but more ecological data is needed on temperature effects.

Control of Eurasian Water Milfoil in Chesapeake Bay. John H. Stenis, Bureau of Sport Fisheries and Wildlife, U. S. Fish and Wildlife Service, Laurel, Maryland, and Vernon D. Stotts, Maryland Department of Game and Inland Fish, Annapolis, Maryland

Eurasian water milfoil (Myriophyllum spicatum) is one of the major aquatic weed problems in North America. The submersed loosely woven blanket growth of the plant, sometimes over 7 feet thick, often completely dominates the water where it grows. Water resources pertaining to waterfowl, sports fish, commercial fish and other activities, are severely damaged.

Milfoil was first detected in the U. S. in 1902. We now have 200,000 acres infested down the east coast. Other states that have it are: Wisconsin (several lakes), Indiana, Ohio, Louisiana and Texas.

Cooperative investigation by the U. S. Fish and Wildlife Service and state agencies of Maryland and Virginia reveal that the butoxyethanol ester of 2,4-D impregnated in attapulgite granules can be used to control this problem plant in the tidal water of Chesapeake Bay. Repeated treatments indicate that granules of 2,4-D applied at rate 20 ea/A will control Eurasian water milfoil during the period of vigorous growth prior to flowering. These applications should be made during low water slack before dead-ebb time.

Other herbicides showing promise are silver, diquat, diquat 2,4-D mixtures, and endothall silvex mixtures.

A New Plot Technique for Aquatic Weed Control Studies.
E. B. Hollingsworth, CRD, ARS, USDA, Laramie, Wyoming

A small plot enclosure was described, made of aluminum sheeting fastened to angle framing, for the purpose of isolating treated areas in a larger body of open water. The enclosure may be easily dismantled and transported from one lake to another, and may be readily moved as a unit within a lake by means of flotation. An inner tube at each corner was used for floating the device. Its use provided for smaller plots, less herbicide per treatment, more plots within a given experimental area, and an overall increase in accuracy. The use of similar enclosures on nonflooded sites was also discussed.

Intercellular Movement of C¹⁴ in Chara Vulgaris, a Nonvascular Aquatic Plant.
T. O. Evrard, R. D. Johnson, and W. E. Chappell, Virginia Polytechnic Institute, Blacksburg, Virginia

It was found that intercellular movement of C¹⁴ is light dependent when applied as NaHC¹⁴O₃ to the water media surrounding Chara vulgaris. In the presence of light the C¹⁴ movement was both acropetal¹ and basipetal². When the Chara was grown in the dark for 24 hours before and after treatment, no C¹⁴ movement was noted from the treated area. This indicated that the C¹⁴ must be converted to a metabolite before it moved from cell to cell.

Carboxyl labeled 2,4-D was applied to certain sections (rhizoid and rhizoid thallus) of eicosane partitioned plants. Autoradiographs showed that C¹⁴ was moved to untreated sites and appeared to increase with increased rates and treatment time. The movement appeared to be more basipetal than acropetal.

Autoradiographs of chromatograms made from extractions of Chara plants treated with carboxyl labeled 2,4-D showed labeled products other than 2,4-D which appeared to be glucose and/or fructose. The carboxyl labeled 2,4-D probably was degraded in the Chara cells and the C¹⁴ removed from the 2,4-D molecule and made available for conversion into sugars which move from the site of degradation to other cells.

Chara cells do have an opening between cells. Some workers consider the whole plant as one cell.

¹acropetal = top of plant treated, movement was to bottom of plant

²basipetal = bottom of plant treated, movement was to top of plant

Variations in Acidity of Cell Constituents as Influenced by Application of Herbicides and Organic Acids. Sigmond L. Solymosy, University of Southwestern Louisiana, Lafayette, Louisiana

It has been reported in the past by the research team of the University of Southwestern Louisiana that increased hydrogen-ion concentration tends to increase the effectiveness of the phenoxy herbicides on Alternanthera philoxeroides.

Effects of Prolonged Use of Certain Herbicides on Soil Microorganisms.
D. D. Hemphill and M. L. Fields, Department of Horticulture, University of Missouri, Columbia, Missouri

The effects on soil microorganisms of annual applications for eight years of DCPA, 10 lb/A and DMPA, 15 lb/A to turf grass plots for the preemergence control of crabgrass was investigated.

These herbicides did not have any significant effect on the ecology of the soil microorganisms. The comparative numbers of the various species in the soil as indicated by plot counts were not changed.

Effect of Activated Carbon and Other Adsorbents on the Biological Activity of Certain Herbicides. D. L. Coffey and G. F. Warren, Purdue University, Lafayette, Indiana

The degree of herbicide adsorption by activated carbon was compared with that of bentonite clay, finely ground muck soil, an anion exchange resin, and a cation exchange resin using a root bioassay. The above adsorbents were tested on several herbicides including CIPC, amiben, 2,4-D, and tri-fluralin.

Comparisons of the herbicide concentrations showed that activated carbon adsorbs from 10 to over 100 times more of each herbicide than any of the other adsorbents tested.

Toxicity of Surfactant-Herbicide Combinations to Lemna Minor (L.)
David L. Sirois and D. W. Staniforth

The effects of selected surfactants on duckweed, Lemna minor, were studied. It was shown that the relative toxicity of surfactants is related to the "hydrophile-lipophile balance" of the surfactants. The more lipid soluble a molecule is the more readily it will penetrate cell membranes and, therefore, the more toxic it will be.

The Disappearance of Atrazine when in Contact with Polyvinyl Chloride Tubing.
Wm. Harold Minshall, Research Institute, Canada Agriculture, University Sub P. O., London, Ontario

To permit collection of xylem exudate from detopped tomato plants at five to fifteen minute intervals polyethylene thistle tubes were substituted for lengths of plasticized polyvinyl chloride tubing (Tygon). Coincident with this substitution the internal concentration of atrazine in the exudate appeared to increase more than 200 percent from an application of 4 lbs. per acre. An investigation of possible causes for the apparent increase indicated that polyvinyl chloride tubing was reducing the concentration of atrazine. In a series of tests where xylem exudate containing three mg. per liter of atrazine was placed in polyvinyl chloride tubing for one hour, from 40 to 60 percent of the atrazine disappeared when determined by the standard chemical analytical procedure. Under similar circumstances from 35 to 45 percent of the atrazine disappeared when placed in pure gum rubber tubing. Polyethylene was without effect. What actually happens to the atrazine has not been determined with certainty. Work is being repeated where polyvinyl chloride tubing was used in studying the implications of metabolic root pressure on the uptake of triazines.

Factors Affecting Adsorption of Atrazine and Diphenamid by Three Varying Soil Types.
R. A. Ashley and E. M. Rahn, University of Delaware, Newark, Delaware

The effect of soil type, organic matter, pH, exchange capacity and herbicide concentration on soil adsorption of atrazine (2-chloro-4-ethylamino-6-isopropylamino-s-triazine) and diphenamid (N,N-dimethyl-alpha-alpha-diphenylacetamide) herbicides by three Delaware soils was studied using a slurry technique.

Results of these tests, with regard to atrazine, showed organic matter to be exerting the greatest influence in soil adsorption of this herbicide. Ability to adsorb atrazine was largely correlated with organic matter content.

With diphenamid, organic matter seemed to be less important. Adsorption apparently was most closely correlated to total surface area.

Phytotoxic Synergism with Soil Applied Herbicide-Insecticide Combinations.
R. G. Nash, CRD, ARS, USDA, Beltsville, Maryland

Combinations of diuron (3-(3,4-dichlorophenyl)-1,1-dimethylurea) with Di-Syston (O,O-diethyl S-2-(ethylthio) ethyl phosphorodithioate) or diuron and phorate (O,O-diethyl S-(ethylthiomethyl) phosphorodithioate) insecticide in soil resulted in phytotoxic synergism. Synergistic effects also were observed during the second and third growth periods in a majority of the reseedings.

Biological Activity and Dissipation of IPC and CIPC. J. V. Parochetti and G. F. Warren,
Purdue University, Lafayette, Indiana

Conflicting reports on the dissipation of isopropyl N-phenylcarbamate (IPC) and isopropyl N-(3-chlorophenyl) carbamate (CIPC) prompted the present investigation on the dissipation and biological activity of these two herbicides. A rapid 40 hour bioassay was employed in a close system by measuring root growth of germinating buckwheat. Buckwheat was an ideal bioassay material in that the biological response from IPC and CIPC was almost identical in soil enabling accurate measurements to 0.25 ppmw. The dissipation patterns of IPC and CIPC were shown to be similar. Under the field and laboratory conditions described, more than 90% of both herbicides were gone in four weeks. CIPC was biologically more active than IPC on all plants tested. Although both herbicides were present in equal amounts throughout their dissipation, CIPC could appear to persist longer in field applications, because it is more toxic to most plants at lower concentrations than IPC.

The Persistence of Simazine in Soil. J. F. Ahrens, The Connecticut Agricultural
Experiment Station, Windsor, Connecticut

The rate of degradation of an herbicide in soil may increase when the herbicide is reapplied for several years. Granular simazine was applied annually in nursery plantings at a rate of 3 lbs. per acre on a Merrimac sandy loam soil. Bioassays of soil cores taken from the plots were used to determine the residues remaining. A year following the last application of simazine residues were greater where only two annual applications had been made than where six annual applications had been made. It is suggested that microflora which detoxify simazine build up in the soil over several seasons. On this same type of soil simazine in granular form was much more persistent than as a wettable powder. Cultivation soon after application slightly increased the persistence of wettable simazine. Its persistence in soil was also increased many-fold when covered by organic mulches or black plastic. Losses of wettable simazine on the soil surface by light destruction and/or volatility are suggested.

Persistence and Decomposition of Dichlobenil in Soil. J. W. Smith, T. J. Sheets,
NC State University, Raleigh, North Carolina and C. I. Harris, CRD, ARS, USDA,
Beltsville, Maryland

In a field experiment at Beltsville, Maryland, residues of dichlobenil persisted from one season to the next in the 0- to 6-inch layer of plots sprayed with 4, 8 and 40 lb/A. However, no significant accumulation occurred from three annual applications of 4 or 8 lb/A to the same plots. Some movement of dichlobenil into the 6- to 12-inch layer occurred on plots sprayed once with 40 lb/A and on plots sprayed annually for 2 years with 8 lb/A. The herbicide was not detectable at the 6- to 12-inch depth of plots sprayed annually for 3 successive years with 4 lb/A.

Loss of dichlobenil in the soil was rapid in the summer and slower in winter due to microbial activity.

Chemical VS. Microbial Degradation of Amitrole in Soil.
D. D. Kaufman, CRD, ARS, USDA, Beltsville, Maryland

Degradation of amitrole-5-C¹⁴ (3-amino-1,2,4-triazole-5-C¹⁴) in autoclaved-potassium azide-, ethylene oxide-, and dry-heat sterilized azide-, soils was compared with that observed in nonsterile soils by measuring evolved C¹⁴O₂. Amitrole degradation occurred in azide-, dry-heat-, and ethylene oxide-sterilized and in nonsterile soils but not in autoclaved soils. Only slight degradation of amitrole occurred in autoclaved soil reinoculated with mixed cultures of soil microorganisms isolated from soil in which amitrole had been rapidly degraded. Addition of EDTA-Na (ethylene-diaminetetra-acetic acid-sodium salt, a chelating agent) to nonsterile and ethylene oxide-sterilized soils reduced amitrole degradation. Addition of carbonaceous residues to amitrole-treated soil stimulated microbial activity but also reduced amitrole degradation.

These results and additional observations indicate that degradation of amitrole, at least in three soils examined, is largely a chemical process, and that microbial involvement is only indirect.

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