menace to seaplane operations. At the request of the Navy a boom or trap was constructed across the river about 10 miles below Palatka to stop all drifting hyacinths.

The most elementary method of removing hyacinth is to drag or throw them onto a bank by hand with rakes or forks, there to dry out and die.

For many years, the common method of removing obstructive jams from navigation channels was to break them up by hand and by boats so that they would float downstream and ultimately reach salt water.

Another successful method has been the "Conveyer." This is a barge-mounted machine in which the hyacinth are pulled or pushed onto an endless belt conveyor which lifts them from the water and deposits them on the bank. Barge-mounted equipment with a boom and forked grapple has also been used to deposit plants on shore. Crusher boats lift the plants out of the water on an endless belt conveyor from which they are passed between heavy, power-driven rollers which crush the hyacinth into a pulp. The plants are then returned to the water to decompose and settle to the bottom. This method results in an almost complete kill of the plants that pass through it, but can only be used effectively in water deep enough to float the barge and where the hyacinth are massed over a considerable area so that they can be fed to the machine continuously and in large amounts.

The most effective mechanical destroyer used has been the sawboat. Whirling saws cut the hyacinth leaves and rizomes, leaving behind a floating mass of shredded material which dies and sinks to the river bed. This usually takes about 2 weeks.

The principal limitation of the sawboat is that it cannot operate in water much less than 18 inches deep. So this, of course, leaves a belt or fringe of undestroyed hyacinth in the shallow water adjacent to the banks of the waterways.

Close study of these methods reveal they all have one thing in common; that is, they are too slow to keep up with the rapid growth of the hyacinth in a large area of infestation.

An effective killer for many years on some of the waterways was spraying the plants with Sodium Arsenite. This solution gave a swift and complete kill. Though quite satisfactory results are achieved with this chemical it is most dangerous to personnel handling it. Then too there was danger to other vegetation and cattle. So much so that the State of Florida imposed the restriction that "no chemical process injurious to cattle which may feed upon the water hyacinth shall be used." From that time on Sodium Arsenite was abandoned in the interest of safety.

The weed killing properties of 2,4-D were first realized in 1941 and the first field trials were made in 1944. In 1946, representatives of the United States Department of Agriculture in cooperation with the District Engineer, Jacksonville, and the Everglades Experiment Station of the University of Florida, conducted tests of 2,4-D in Florida to prove that it is harmless to fish, cattle and wildlife.

Further tests and extensive field operations have shown that the basic rate of application should be approximately 2 pounds of acid equivalent per acre of hyacinth. This may be applied in various concentrations depending on weather conditions and the size of the hyacinth being sprayed. It has been found that when using chemicals having 4 pounds of acid per gallon a good kill can be obtained with a mixture of 2 to 4 pints of chemical to 50 gallons of water.

Small inboard motorboats were developed for use in spraying navigation channels; they are economical and effective and are still being used in appropriate locations.

In March 1960 operations were started on the Expanded Project for Aquatic Plant Control in cooperation with the State of Florida Game and Fresh Water Fish Commission.

It was realized that the inboard motorboats would not operate in the extremely shallow waters that now had to be treated. A study of many types of equipment was made and the airboat was chosen because it best met the overall requirements. It was found during operations that an airboat could cover the same areas as an inboard or outboard boat in about half the time and do a better job. Airboats are also able to work in exteremely shallow waters, going over logs, through heavy growths of hyacinth and working in hyacinth jams in a fraction of the time required for sawboats, inboards and outboards. In many instances airboats work in places no other type of equipment can operate. Overall, the airboat is proving to be the most economical and effective piece of floating equipment used in destroying hyacinth.

Where large masses of hyacinth are concentrated in open areas the most economical method of initial destruction is by aircraft spraying. This type of spraying has been utilized in all areas where it has been practical.

The most efficient spray pump being used by the Corps is the high pressure John Bean Royallette 10 GPM Pump. This is operated at 300 psi with a John Bean quick-acting trigger valve spray gun with adjustable barrel using a number 10 tip.

In areas now being treated under the APC Program by the Corps of Engineers and the Game and Fresh Water Fish Commission, the majority of the hyacinth remaining are in less than 18 inches of water. In the short time this program has been in effect we feel that real progress has been made and great benefits have been achieved.

On the Withlacoochee River one can see fish beds in areas where fish could not live before because of heavy infestation of hyacinth. Huge floating rafts of hyacinth drifting from place to place which did untold damage to fish beds and fish populations in lakes and streams, no longer exist, thanks to this program.

Water Hyacinth Control With Amitrol-T

John E. Gallagher

This meeting will discuss the history, the economic importance, and the control of Water Hyacinth. The discussion on control will deal with the mechanics of spray operations, as well as mechanical methods of control. As the meeting progresses, it will be obvious that chemical control and 2,4-D are synonymous. Newer chemicals have not been field tested since about 1948.

If the Water Hyacinth problem is an increasing one, and it should be considered so if current methods have not been able to prevent its expansion, new methods and chemicals should be tested at the research level. Once proven practical, whether for economic reasons or because of increased biological activity, these methods should be field tested to prove their worth. After three years of controlled experimental work including some field operational test, it seems that Amitrol-T can offer both economic and biological advantages.

It was my pleasure to work with Dr. Seaman of the USDA Aquatic Weed Research Laboratory. What I will say here is in essence a report on the work conducted by Dr. Seaman over the past three years. I will use periodic reports made by him to show the initiation and development of Amitrol-T for the control of Water Hyacinth.

The work started in 1959, there had been little systematic research work done on Water Hyacinth since 1948 when 2,4-D proved effective.

Because of the many improvements in the formulation of 2,4-D, a project was set up to compare the new with the standards to see if these formulations improvements could be translated into increased weed kill. Amitrol-T was added to the list because it had proven to be more effective on other aquatic species and also seemed to translocate well in stoloniferous plants.

In summarizing the 1959 work Seaman had this to say:

Four different formulations of 2,4-D, and formulations of emid, fenac, and amitrol (+NH_4SCN) were evaluated at several application rates for control of water hyacinth in a 3-replicate experiment. The amitrol formulation was more effective than any other material at equivalent rates, and yielded nearly complete control at 2 lb/A. Practical control was obtained by 4 lb/A applications of the butoxyethanol ester, emulsifiable acid, and diethanolamine salt of 2,4-D, and the sodium salt of fenac, but emid and the water-in-oil emulsion of 2,4-D were practically ineffective at less than 6 lb/A rates.

The slow-acting but remarkable control of water hyacinth by the amitrol formulation was especially interesting, because this herbicide might be used in areas where 2,4-D compounds are hazardous to crops and ornamentals. The less-mature weeds of one replicate series were more difficult to kill by all treatments than were the more mature weeds of the other two series, but it was thought that effects of all treatments might be improved by reducing the application volume which would serve to increase the effective concentration contacting the plants.

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This work showed that Amitrol-T was effective, but additional work was needed to prove out the early findings and determine the limits of use. The following report presented by Seaman at the 1961 Southern Weed Control Conference describes the work done in 1960. Volume of carrier, rates of application, and component parts of the Amitrol-T formulation were tested to determine thir effect. Seaman summarized in abstract form. "A formulation containing 2 lb. of 3-amino-1,2,4-triazole (amitrole) and 2 lb. of ammonium thiocyanate (NH4SCN) per gal. (amitrole-T), gave over 90% control of water hyacinth (Eichhornia crassipes) at rates of 1.5 and 2.0 lb. ai/A, with respect to amitrole, when applied in water at 100 gpa. When applied at 200 gpa, amitrole-T gave over 90% control at rates of 0.5, 1.0, 1.5, and 2.0 lb. ai/A. Similar 3-month evaluations of control by the diethanolamine salt of 2,4-dichlorophenoxyacetic acid (2,4-D) indicated that only 45% control was given at 6 lb. ae/100 gal/A, but 83% control resulted after treatment with 6 lb. ae/200 gal/A, and correspondingly less control was given at lower rates with either volume. The maximum effects of amitrole-T took about 4 weeks longer to develop than did those of 2,4-D, but regrowth of vegetative offshoots (daughter plants), and consequent loss of control, was less in plots treated with amitrole-T than with 2,4-D.

The relatively poor control given by 2,4-D was thought to be related to its poor transport through stolons from parent plants to attached offshoots. Since amitrole has been shown to be more mobile than 2,4-D in other plants, probable superior translocation of amitrole-T may explain its superior control through effective repression of offshoot regrowth. The offshoots were probably protected somewhat by the mature foliage in the dense stands of weeds of this experiment.

The applications of both herbicides at 200 gpa gave better control than those at 100 gpa presumably because the higher volume provided better total coverage and more offshoots were contacted by the spray solution.

Preparations of amitrole alone, amitrole plus hydrochloric acid, NH4SCN alone, and mixtures containing amitrole: NH4SCN ratios of 1:0, 1:0.5, 1:1, 1:2, and 1:3 were also applied to differentiate the roles of these amitrole-T components in terms of water hyacinth control. Amitrole alone and amitrole plus hydochloric acid behaved similarly and yielded only 15% control at 1 lb/100 gal/A and 50% control at 2 lb/100 gal/A. NH4SCN alone was totally ineffective at 3 lb/A. The amitrole: NH4SCN mixtures, each applied at 1 lb ai/100 gal/A with respect to amitrole, all gave better control than did amitrole without NH4SCN at the same rate. The 1:1 mixture, representing commercial amitrole-T in this series, gave 80% control, the 1:2 mixture gave 92% control, and the 1:3 mixture gave 56% control. Further work is planned to ascertain whether or not the apparent optimum control effects given by the 1:2 mixture is sufficiently significant to recommend a change in the commercial formulation to make it a more effective herbicide for water hyacinth control.

Amitrole is not regarded as hazardous to crops and ornamentals as 2,4-D. Since amitrole-T was more effective in single applications than 2,4-D at nearly-equivalent treatment costs, this formulations may be developed as an alternative herbicide to 2,4-D for control of water hyacinth in agricultural and residential areas.

The 1961 work was presented at the Weed Society of America meeting at St. Louis. This was a summary of the three years work. The continuous effectiveness of Amitrol-T was shown, with a possible explanation as to why it had worked well for three years. This abstract summarizes the finding of three years work.

Field tests have been conducted during the past three years to evaluate the efficacy of formulations of 3-amino-1,2,4-triazole (amitrole) to control water hyacinth (Eichhornia crassipes (Mart.) Solms.). Comparisons were made with 2,4-dichlorophenoxyacetic acid (2,4-D), the main herbicide being used for water hyacinth control. Tests in 1960 and 1961 consistently showed that a formulation of amitrole-T containing 2 pounds each of amitrole and ammonium thiocyanate (NH4SCN) was more effective in single applications at rates of 0.5 to 2 pounds ai (amitrole) per acre than similar applications of 2,4-D at 2 to 6 pounds per acre.

Although maximum effects of amitrole-T took about four weeks longer to develop than did those of 2,4-D, regrowth and consequent loss of control were less in plots treated with amitrole-T than in those treated with 2,4-D. Regrowth appeared mainly due to vegetative offshoots probably not contacted directly by the spray solution. In a separate laboratory experiment, amitrole-T applied only to parent plants killed attached offshoot plants, but offshoots survived similar treatments with 2,4-D. It therefore seemed likely that the more effective expression of regrowth by amitrole-T was due to its superior translocation through stolons from parent to offshoot plants.

Amitrole alone was not as effective as mixtures containing NH4SCN, which appeared to be synergistic to the action of amitrole on water hyacinth. Increasing concentrations of NH4SCN gave corresponding increases in control up to an apparent optimum ratio of 1 part amitrole to 2 parts NH4SCN by weight. A higher concentration of NH4SCN in the mixture reduced the effectiveness below that of the commercial formulation of amitrole-T.

In reporting this work, it seems evident that the consistent control in each of three years at different locations offers proof of increased biological activity. The importance of a single application as compared to a minimum of two with 2,4-D makes the economic contribution of Amitrol-T to water hyacinth control significant.

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The Correlation Of Mosquito Breeding To Hyacinth Plants

By E. L. Seabrook[1]

This paper is somewhat basically the same as worked up some years ago relative to Palm Beach County's desire and willingness to cooperate in a project for hyacinth eradication, which was in response to a notice of public hearing issued by the U. S. District Engineer's office on May 3rd, 1946. Much of the basic contents of this paper was presented at a public hearing at West Palm Beach, Florida on June 18th, 1946.

Reference is made to Page 9, paragraph 2 and 3 of a report dated July 18th, 1898 by Assistant Engineer J. W. Sackett to Lt. Col. W. H. H. Benyaurd, Corps of Engineers, U. S. Army, which is contained in a letter document No. 91 from the then Acting Secretary of War, and which concerns Water Hyacinth Obstructions.

According to records, hyacinth plants were introduced into the St. Johns River near Jacksonville, Florida by a "little old lady" years ago. After their establishment, it is of interest to note that as pertains to Public Health there was some concern at first as borne out by the following excerpt — "It was apprehensive that the accumulation of these floating masses would be a serious menace of the health of the vicinity, but these fears do not seem to be well grounded, and it is now thought that the plants absorb matter deleterious to health. The impression prevails that upon upper portions of the river, noted for malaria, where the plant has accumulated extensively, much less sickness of the malarial type prevails than formerly. In places in Louisiana where large masses of the plant have been piled upon the banks of canals and bayous and left there to dry up and decay, no bad effect upon the health of those living in the vicinity has been observed. It is therefore safe to assume that as an obstruction to navigation the plant need only be considered, and in adopting methods for destroying the plant or abating its growth, sanitary conditions do not need to be considered."

Since 1898, the date of Assistant Engineer J. W. Sackett's report on hyacinths as related to public health, considerable strides have been made in the advancement of science, especially in the chemical field, for the control of these plants. These developments have proven of paramount importance for the control of malaria and culicine mosquitoes found in association with these aquatic growths. Entomological and related sciences have established that when these plants thrive in abundance,

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