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AQUATIC PLANT MANAGEMENT IN DRAINAGE CANALS OF SOUTHERN ARGENTINA

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ABSTRACT

A multi-disciplined approach to the problem of aquatic weeds in drainage canals was considered the most appropriate way of managing their harmful effect in an important irrigation zone in Argentina. The results of this planning process include gathering of: information on the biology and ecology of the two species under study; making recommendations relating to the timing of control programmes, the type of chemical herbicides to be used, and their application techniques; and development of strategies to prevent the formation and dissemination of new plants.

DESCRIPTION OF THE STUDY AREA

The area under study is situated in the southern part of the province of Buenos Aires, Argentina (62° 37′ W, 39° 23′ S) where approximately 90,000 ha belonging to 1,400 producers are currently under various intensities of irrigation. The land is dedicated to the cultivation of vegetables, cereals, fruit, and the production of fodder either for direct domestic use or for ensilage.

Water for irrigation comes from the Colorado river and is distributed by a network of 331 km of main irrigation canals and more than 3,000 km of secondary and tertiary canals. Excess water after irrigation is collected by minor canals and taken to a network of approximately 400 km of principle drainage canals, which eventually flow into the Atlantic Ocean.

The landscape is almost flat with only a very slight incline (0.002%), and the water is thus slow to drain. As a result the drainage in particular are easily blocked by the growth of aquatic weeds.

The main aquatic weed problem occurs in the drainage canals where the submersed species *Potamogeton striatus* Ruiz et Pavon and *Chara contraria* A. Braun ex Kütz, grow extensively. One of the principal explanations for this phenomenon is the fact that the water in the drainage canals is transparent and the light penetration thus enables growth of submersed species. The water coming directly from the river along the irrigation canals on the other hand is opaque, due to the high content of clays and other substances in suspension, thus impeding light penetration.

The presence of these weeds in the drainage canals impedes the flow of water, resulting in reduced drainage and problems of salinity in the soils of the cultivated areas.

Until recently no systematic programme based on experimental data was available for the control of submersed weed in this area. The only method used to date has been of a mechanical nature, which is too costly and slow to deal with the large areas involved.

APPROACH

About five years ago a multi-disciplinary programme was commenced with the objective to develop more rationalized control of the two major weeds. The approach is based on a proposal by Fernández (1) for an multi-disciplined analysis of the problem. The first stage of the study involved experimental trials to select control methods based on laboratory and field tests, and simultaneous studies on the biology and ecology of the plants.

It was recognized from the outset that one of the main obstacles to a control programme for canal weeds is the almost total lack of knowledge on the biology and ecology of the weeds of the area, especially as regards growth, reproductive capacity, and survival and invasion mechanisms in the region. The first part of the study was based on the hypothesis that this kind of basic study would provide necessary information revealing the reasons for such successful growth of these plants in the area which would potentially contribute to the adoption of more adequate control strategies.

A broad outline of the two main parts of the programme is provided in Figure 1. Obviously parts 1 and 2 of the programme are closely interrelated. As new information acquired from either part is evaluated in terms of its potential use in the development of control strategies. Some of the results obtained to date are briefly presente in the following sections.

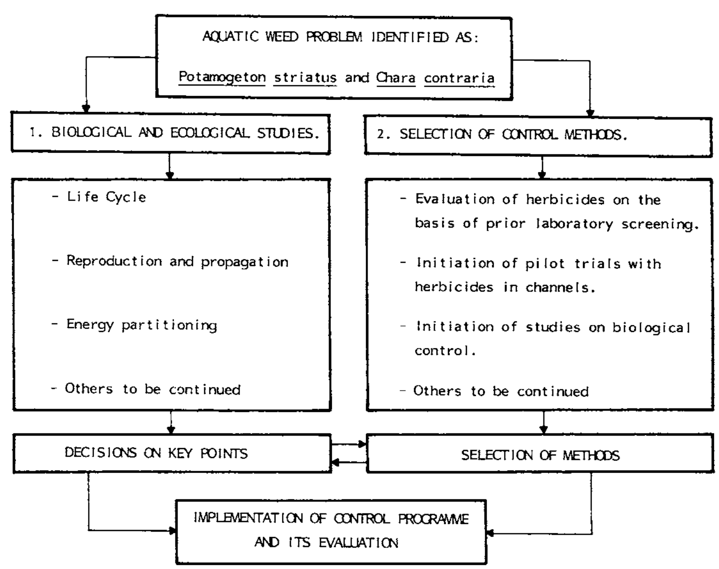

Figure 1. Major components in the aquatic weed management programme developed for the drainage canals in South Argentina.

BIOLOGICAL STUDIES

Growth of *P. striatus* occurs in spring and summer when stems can attain a length of up to 3 m, following the direction of the current. The species has a robust system of roots, stems and tubers, and undergoes three distinct stages of development: a) growth and vegetative expansion from late winter to late spring; b) a reproductive stage from the middle of spring until the end of summer, mainly vegetative at first and then sexual; and c) a period of maintenance and survival during the state of vegetative rest, occurring partly in autumn and in winter. Its maximum biomass of about 500 g d.wt/m^2 was obtained in February. Experiments undertaken on plants developed from tubers showed a relative growth index of 0.27 g/g day during their first growth cycle.

Potamogeton striatus reproduces sexually by means of drupaceous fruits which are dispersed by the water when they become detached from the plant. *P. striatus* has a vigorous system of vegetative reproduction by means of underground stems and tubers. No formation of turions was found, though the detachment of shoots capable of developing into new plants was observed. In controlled experiments on plants grown from tubers it was found that during the first year of growth the plants were capable of developing underground stems as long as 14.2 m with as many as 17 tubers per plant. The growth of young plants grown from tubers was shown to be affected by high saline concentrations, though they demonstrated a high level of tolerance to pH (2).

During the first annual development cycle the dry weight of aerial biomass of *P. striatus* grown from tubers represented 67.7% of total maximum biomass. During the months of vegetative rest the subterranean system of the plant represented 79.3% of its total dry weight, indicating the importance of the subterranean systems to the survival strategy of the species. Energy expenditure of reproduction was estimated at 27.3% of total plant weight.

Chara contraria forms a dense mass of growth anchored to the bottom of the canal extending to the surface of the water. Regrowth was observed in early spring, particularly from the stems which had survived the vegetative rest of the winter period. In mid-spring the formation of oospores begins and continues until well into the summer. In autumn, the oospores are liberated and join the oospore bank at the bottom of the canal. The maximum peak of vegetative biomass was 1.6 kg dry.wt/m^2 observed in January (7).

Chara contraria reproduce by oospores of sexual origin and by means of stem segments which take root easily in the mud at the bottom of the canals. A preliminary estimate of the oospore bank on the canal bed indicated a density of over 100,000 oospores per m^2. Seventy percent of freshly harvested oospores germinated under laboratory conditions. Oospores stored in the laboratory either under dry or humid conditions showed a high percentage of germination after one year (6).

EVALUATION OF CONTROL METHODS

Laboratory tests were performed in order to screen potential of several herbicides for the chemical control of *P. striatus* and *C. contraria*. The herbicides were used at different concentrations for short and long periods of contact testing, ranging from 30 min to 48 hrs. Preliminary testing showed that acrolein, paraquat, diuron, diclobenil and fluridone proved to be most promising for manageing with *P. striatus*, and diuron and copper sulphate for controlling *C. contraria* (3, 4).

The best results for control of *P. striatus* were obtained using low concentrations of acrolein applied over long periods of injection. The recommended concentration proved to be 2-5 ppm over an injection period of 24 hrs, resulting in a reduction of biomass ranging from 30 to 50% over a distance of 7-10 km downstream from the point of injection. Three successive applications at regular intervals throughout the growing season were sufficient to ensure proper functioning of the canals and it was observed that early chemical treatment inhibited development of vegetative reproductive structures. *C. contraria* proved highly susceptible to all applications of acrolein, even at the lowest concentrations and shortest injection times (1-2 ppm in 3 hrs).

In view of its low cost and easy availability, pentahydrated copper sulphate constitutes a viable alternative for the control of *C. contraria* in the canals, though it proved ineffective against *P. striatus*. A simple method was developed for controlling the concentration and injection times of this substance: a perforated 50 l polyethylene drum containing the chemical was submersed in the water of the canal; taking into account the volume and velocity of water in the canal, the quantity of chemical liberated depends on the number of open orifices in the herbicide container. By measuring the amount of copper ions in the canal water it was possible to establish that between 2 and 5 ppm copper ions are sufficient to control the algae over distances of 500 to 1000 m depending on the type of canal and the time of year. Putting various drums of herbicide at regular distances enhances the efficiency of the treatment. One single application of copper sulphate during the summer was sufficient to impede the formation of *C. contraria* oospores during the rest of the growing period.

Research is currently being conducted on a promising Argentine species of the apple snail *Ampullaria canaliculata*, regarding its possible introduction as a biological control against *C. contraria*. Four years of investigation and small-scale trials have shown that the snails feed with voracity on the mentioned algae, thus reducing its growth. A population of *Ampullaria* is being successfully maintained in a section of drainage canals where future research on the life cycle of the snail and its effect on aquatic flora will be determined.

The multi-disciplined approach presented for dealing with weed problems in drainage canals in Argentina has proved successful in development of control programmes. New information has been obtained on the biology and ecology of the weeds enabling recommendations to be made on the appropriate timing of control programmes and on strategies for preventing the formation and dissemination of new plants. Future research will aid in the optimization of these programmes.

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REFERENCES

1. Fernández, O. A. 1982. Manejo integrado de malezas. Planta Daninha. V: 69-79.
2. Irigoyen, J. H. 1981. Crecimiento y desarrollo de *Potamogeton pectinatus* en los canales de desagüe del Valle Bonaerense del Río Colorado. II Reunión sobre malezas subacuáticas en los canales de desagüe de CORFO. Publ. CIC, La Plata: 47-69.
3. Irigoyen, J. H. 1981. Evaluación de herbicidas para el control de *Potamogeton pectinatus* y *Chara* sp. II Reunión sobre malezas subacuáticas en los canales de desagüe de CORFO. Publ. CIC, La Plata: 113-130.
4. Irigoyen, J. H. and Brevedan, R. E. 1983. Laboratory Trials of Fluridone on Sago Pondweed. J. Aquat. Plant Manage. 21: 36-37.
5. Peinemann, N., Ramos, N. E. and Iturralde, J. A. 1979. Balance salino del Valle Inferior del Río Colorado. Centro de Capacitación de CORFO-Río Colorado. 1, 59 p.
6. Sabbatini, M. R., Fernández, O. A. and Argüello, J. A. 1986. Estudio sobre la germinación y conservación de oósporas de *Chara contraria* A. Braun ex Kütz. (Charophyta). Phyton. 46(1): 69-76.
7. Sabbatini, M. R., Irigoyen, J. H. and Fernández, O. A. 1986. Phenology and biomass dynamics of *Chara contraria* A. Braun ex Kütz. in drainage channels of a temperate irrigation area in Argentina. Proceedings EWRS/AAB 7th Int. Symp. on Aquatic Weeds, Loughborough, England; 15-19 September, 1986: 285-289.