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A portion of the experimental plot on the Florence Bloom dam at Delta Park in early winter.

CONTROLLING WATER HYACINTH

Successful results of integrated management experiment at Delta Park

*The Water Hyacinth (*Eichornia crassipes*), which is also considered to be the world's worst water weed, is proving to be the most intractable of the five major aquatic weeds under biological control in South Africa. Despite the release of five insect biocontrol agents against Water Hyacinth, its populations continue to reach newsworthy proportions on major rivers and dams – the recent outbreak on Benoni Lake is one of many examples. This aggressive invader is a symptom of the larger problem of eutrophication – excessive nutrient enrichment usually by nitrates and phosphates because of activities such as sewage disposal and land drainage.*

A report by the Water Research Commission encouraged investigation into the use of sublethal doses of herbicide in the integrated control of this highly invasive species. Research was undertaken into a combination of biological and chemical control by Master's student Naweji Katembo and Prof Marcus Byrne of Wits University's School of Animal Plant and Environmental Sciences. This experimental work was done at Delta Park in Johannesburg.

This is a follow-up to the earlier article in EM (*July/Aug 2008 page 28*) and relates to their discovery that glyphosate based herbicides can be used in an integrated manner with insect biological control agents. This management technique has the capacity to suppress the weed's growth in spring and summer, when the plants increase in size, and during winter, when the plants reproduce asexually.

It has been found with Water Hyacinth populations countrywide that biological control alone is not an entirely effective long term management proposal, largely because the nutrient levels in many water bodies are so high that the plant outgrows the biocontrol's effectiveness. The higher the nutrient levels, the better the chance of vast increases in biomass. New Years Dam in the Eastern Cape which has low nutrient levels is under effective biocontrol. Winter cold also kills the adult weevil populations and although some larvae are able to over-winter, the extent of damage achieved is not as high as it should be. Site instability, caused by flooding, also sweeps away the plants with their biocontrol agents. The latter take longer to recover from the disturbance than the weed.

At the Wits experimental field site at Delta Park, spraying with a sublethal dose of glyphosate was found to have a retarding effect on the plant, although there was seasonal variation in the results. Whereas the 0, 8% glyphosate dose had caused retardation in the production of daughter plants (ramets) in the laboratory, in the field, autumn was the only sample period in which there was marked retardation, equivalent to the laboratory results. In summer at Delta, daughter plant production was only slightly retarded.

Katembo comments that this illustrates the need for thorough field testing, away from the controlled conditions of the laboratory, with different temperatures and nutrient levels affecting the size of the plants and their hardiness.

Plant biomass was also measured, and in this case there was found to be a significant reduction in biomass on the sprayed areas at the field site, in comparison with the unsprayed (control). Here the lab results were repeated in the field.

Ashwini Jadhav, a Wits PhD student, discovered in the laboratory that the performance of the weevils was better on the

sprayed plants, whereas Katembo found in the field that there was no significant difference between the weevil's performance on the control and sprayed areas. It was meaningful to discover, however, that the weevils were not deterred by the spray on the plants. The number of feeding scars per cm^2 on the leaves of the plants was measured and here the laboratory results were repeated in the field with more feeding scars being found on the sprayed plants than on the control plants.

RIGHT: The attractive flowers of the notorious Water Hyacinth. An inflorescence can produce up to 2 000 seeds and the seeds can survive for up to 20 years.

BELOW: The weevil, *Neochetina eichhorniae*, used as a biocontrol agent on Water Hyacinth.

Anthony King

Hildegard Klein

Naweji Katembo

The Water Hyacinth infestation at Delta Park at the start of the clearing operation in preparation for the experiment. The extensive biomass of the plants is evident.

The chemistry of the sprayed plants was then considered to establish why the weevils preferred feeding on the sprayed plants. Interesting results were found when the carbon to nitrogen ratio was established to be significantly higher in the sprayed plants – a marked increase in carbohydrate levels was evident in comparison to the control. The glyphosate herbicide was responsible for the increase in carbohydrates and this is the reason that the weevils feed more on the sprayed plants.

Katembo is pleased with the results of his research but is aware that they are far from the answer to total control of Water Hyacinth. Biocontrol alone does not always give good results but evidently when integrated with sublethal doses of herbicide both ramet and biomass production can be reduced. The appropriate sublethal dose of herbicide has been established that will stunt plant growth and reproduction without harming the weevil populations. High levels of nutrients did not reduce the stunting effect of the herbicide dose and did not adversely affect weevil numbers. The low dose of herbicide had no effect on the growth or survival of tadpoles – and the Water Hyacinth itself was found to present a greater threat than any herbicide dose used in the experiment.

It is recommended that herbicide be applied to recalcitrant Water Hyacinth sites as late in autumn as temperatures will allow, before the plants reproduce asexually by means of ramets, and again in spring, just as the new leaves are starting to develop and the plants to add biomass by leaf elongation.

On the strength of the research, a simple management plan has been developed to guide water managers in the actions that should be taken in terms of combining biological control with herbicidal control under different climatic and nutrient conditions.

Byrne and Katembo comment that the management plan is being taken to farmers and they recommend for large infestations along rivers, that aerial spraying should be carried out with the full 3% dose of glyphosate to kill a wide strip of Water Hyacinth, but leaving the plant along the periphery of the river as a refuge for biocontrol agents. The herbicide spray will drift to these plants and stunt their growth but the insects will remain in place – this will also serve to reduce possible damage to reeds or other marginal plants.

Byrne comments that Water Hyacinth can be managed in this integrated manner by any able person, but preferably one who sets himself up as a 'champion' for the cause. He said the programme at Enseleni in KZN was a good example of effective integrated control, where many kilometres of river are now under complete control with about 10% water hyacinth cover which is acceptable to the water users. Complete eradication of a weed is very difficult to achieve.

In summary, biological control, maintained by the active release of agents and their management through the creation of refuges of plants, along with the use of low herbicide doses (generally accounted for by spray drift), is recommended for all levels of Water Hyacinth infestation, except where complete eradication is required. Agents need to be reintroduced if they are lost through flooding or frost. Ultimately, every effort needs to be made to control nutrient flows.

Article compiled by Carol Knoll