Abstract

Eichhornia crassipes (Martius) Solms-Laubach (Pontederiaceae) (water hyacinth), a neotropic noxious weed of South American origin, is counted among the "big five" aquatic weeds in South Africa. The weed causes dramatic ecological and economic losses in infested areas. Its control is facilitated by the release of biocontrol agents, mainly *Neochetina eichhorniae* (Warner) and *Neochetina bruchi* Hustache (Coleoptera: Curculionidae). Control efforts via biocontrol are hampered, mainly by the climate incompatibility of the agents, aggravated further by the indiscriminate use of lethal doses of glyphosate based herbicides. The lethal doses interfere with the successful establishment and persistence of the biocontrol agents, thus undermining their impact. Continued use of herbicide kills the water hyacinth mat and as a result, the immature stages of the agents are killed. If biocontrol is to succeed as a control strategy, then low doses of the herbicide need to be advocated. It was hypothesized that a low dose will constrain the vegetative and reproductive capacity of the weed, while maintaining the habitat for the biocontrol agents. Consequently, this study was conducted to identify a retardant dose of glyphosate herbicide and test its effect on the *Neochetina* weevils. A concentration of 0.8% (0.11g m^{-2} or 2880mg a.i /L) glyphosate based herbicide, sprayed at 150 L ha^{-1} was proved to retard the vegetative and the reproductive growth of the weed, in terms of leaf and ramet production. Further, the retardant dose did not have any detrimental effects on the adult weevils and its larval stages. Weevil herbivory was also enhanced by the retardant dose. Furthermore, the retardant dose did not have any detrimental effects on 'plant quality' as evidenced by % nitrogen level in plant tissues such as crown and leaves. Contrary to expectation however, the combined effects of the retardant dose and *Neochetina* herbivory (0.8%+Ne) did not result in the production of lower number of ramets or leaves than water hyacinth plants dosed with 0.8% herbicide alone. Water hyacinth biocontrol agents in South Africa are subjected to frosty winters with low temperatures which cause the biocontrol agents to decline to an overwintering larval population that fails to catch up with the weed as it rebounds from the frost in spring. This hypothesis was tested in this study at 12 water hyacinth infested sites, which were grouped as temperate and sub-tropical sites. At both the temperate and subtropical

sites, water hyacinth plants produced ramets (daughter plants) through autumn and increased biomass during summer. However, weevil numbers were very low at these sites, as evidenced by adult counts and feeding scars, indicating a marked seasonal asynchrony between the phenologies of the weevils and water hyacinth. Hence, intervention by seasonal applications of the herbicide is crucial to constrain weed growth. Herbicidal applications during autumn and spring inhibited the growth of the weed without adversely affecting the adult weevils or immature, immobile stages. Continued use of herbicides raises concerns of effect on non-target species, such as amphibians. Results from this study indicate that a direct application of a retardant dose of glyphosate did not kill or affect the growth of the *Xenopus* larvae, as determined by survival and body lengths. However, under laboratory conditions, this study has shown for the first time that an invasive aquatic weed (water hyacinth) was more lethal to an aquatic vertebrate (*Xenopus* larvae) than a herbicide advocated for its control. This study conclusively shows that retardant dose of glyphosate herbicide can be integrated with biocontrol to provide a sustainable and eco-friendly technique with which to combat water hyacinth infestations in South Africa.