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Incorporating biocontrol agents into an integrated management plan: Practical considerations

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INTRODUCTION

Since its inception, numerous definitions have been proposed for the concept of integrated pest management, or simply IPM (Bajwa and Kogan 1996). However, they all have a common theme: IPM is ". . . an ecologically based, environmentally conscious method that combines, or integrates, biological and nonbiological control techniques to suppress weeds, insects and diseases." (Frisbee and Luna1989). Biological control by natural enemies (predators, herbivores, parasitoids, and pathogens) should be the foundation of any IPM program because of its broad applicability to virtually all groups of pest organisms (Rosen et al. 1996).

Recently, IPM has been divided into three specific areas of application: agricultural, community, and environmental (University of Florida Extension 2006). Clearly, integrated management of invasive aquatic plants is within the purview environmental IPM.

In aquatic systems, biological control can be integrated with mechanical removal of the target weed, application of herbicides, and plant competition (revegetation). Combining different tactics not only can increase the level of control via additive or synergistic effects (Shabana et al. 2003, Cuda et al. 2016), but more importantly prolong the useful life of a limited number of herbicides labeled for aquatic use (Netherland 2014). The purpose of this article is to briefly review some of the basic aspects of incorporating biological control agents into IPM plans for invasive aquatic weeds. Many of these topics have been discussed in other publications (e.g., Harley and Forno 1992, Buckingham 1994, Julien and White 1997, Coombs et al. 2004, Cuda et al. 2008) but will be briefly summarized here. The following physical, biological, and technical factors, working either alone or in combination, should be considered when developing IPM plans because they can ultimately affect biocontrol agent establishment ("biological success") and population growth ("impact success") (Forno and Julien 2000).

A word of caution is in order. Biocontrol agents can be biologically successful in establishing and sustaining high population densities on the target weed but may not provide the desired level of control or impact on the weed. As a result, Hoffman (1995) proposed a system that describes biological control success in practical terms that are readily understood by aquatic plant managers and bureaucrats. For example, biological control is defined by Hoffmann (1995) as "complete" when no other control method is required, "substantial" when other methods such as herbicides are still required but at reduced level, and "negligible" when other control methods are necessary because the established biocontrol agent failed to control the weed. Measuring biological control success in economic terms (e.g., reduced herbicide applications) has an additional benefit. Funding agencies are more inclined to continue supporting biological control when they can see a return on their investment. In South Africa, for example, a cost savings of over 80% was achieved by combining biocontrol with herbicides instead of using herbicides alone (Van Wyk and Van Wilgen 2002).

Julien (1997), however, argues that the use of short descriptive terms to define success, such as complete, substantial, or negligible, oversimplifies reality because variations in time and space are not taken into account. For example, in those countries where the flea beetle (*Agasicles hygrophila* Selman and Vogt) (Coleoptera: Chrysomelidae) was released on alligatorweed [*Alternanthera philoxeroides* (Mart.) Griseb], biological control can range from complete to negligible depending on the season, geographic area, and habitat. However, the value of Hoffman's system is that it equates the degree of biological control with the extent to which other control measures must be used, which ultimately is the goal of IPM.

When resources are limited, a simple method for documenting the impact success of the biocontrol agent over time is through a series of color photographs taken from the same fixed point (Harley and Forno 1992, Julien and White 1997). It is imperative that the same scene is photographed from the *exact* location of previous photographs. This can be best accomplished by carrying a copy of the first photo for comparison with subsequent photos, and if possible, including a conspicuous natural landmark to compare changes over time (Harley and Forno 1992, Julien and White 1997).

PHYSICAL FACTORS

Density-independent factors such as climate and weather (Andrewartha and Birch 1954) may have a profound impact on biological control agent establishment and survival (Vogt et al. 1992), especially when juxtaposed with plant architecture. In Florida, for example, water temperatures may exceed 40 C for extended periods during the summer, especially in the upper portion of the canopy of the aquatic weed hydrilla [*Hydrilla verticillata* (L.f.) Royle] (Cuda et al. 2008). Eggs and newly hatched larvae of the Indian hydrilla

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leaf miner (*Hydrellia pakistanae* Deonier) (Diptera: Ephydridae) are particularly vulnerable to high temperature; in laboratory studies, a constant water temperature of only 36 C prevented adult emergence (Buckingham and Okrah 1993). However, older larvae are capable of moving between leaf whorls (Center et al. 1997), and perhaps migrate to whorls deeper in the canopy to avoid extreme temperature. Furthermore, seasonal timing and diurnal temperature patterns may dictate whether early morning or late afternoon releases of biological control agents are warranted. For example, nocturnal insects should be released during the morning and diurnally active insects in late afternoon or early evening; this provides ample time for the biocontrol agents to adapt to their new surroundings (Buckingham 1994).

Limnological conditions also should be assessed when making biocontrol agent releases. Static waters or lentic ecosystems (i.e., lakes and ponds) are more conducive to establishment than flowing or lotic systems (i.e., rivers and springs) because constant water movement can dislodge the biocontrol agents from their host plants. Within a lake or pond, water depth may be another factor precluding biocontrol agent establishment because some submersed plants growing in deeper water may be more difficult for the biocontrol agent to locate or increases its vulnerability to fish predation (Newman 2004) (see also next section).

BIOLOGICAL FACTORS

Life cycle requirements of some insect biological control agents can affect their establishment and survival. For instance, larvae of the Indian hydrilla tuber weevil (*Bagous affinis* Hustache) (Coleoptera: Curcuionidae) severely damage the tubers of hydrilla in the weevil's native range of India and Pakistan; seasonal fluctuating water levels facilitate development and pupation of the larvae in exposed tubers (Buckingham 1994). In hindsight, the tuber weevil probably should not have been released because drawdown conditions that expose the tubers for the weevil to complete its life cycle rarely occur in Florida or most of the southeastern United States.

Although great care is taken to ensure candidate weed biological control agents are released without their co-evolved natural enemies, resident natural enemies (i.e., generalist parasitoids, predators [including fish], or pathogens) are capable of exploiting this new resource (Cuda et al 2008). Herbivores introduced into new geographical regions as weed biocontrol agents often become prey items for these natural enemies (Cornell and Hawkins 1993, Newman 2004, Coon et al. 2014, Minteer et al. 2016). Weed biocontrol practitioners should carefully consider the potential for acquiring novel parasitoids when selecting agents to avoid reducing biocontrol agent effectiveness and apparent competition with native ecological analogues of the agent (McFadyen and Jacob 2004, Paynter et al. 2010).

Probably the most important reason for hydrilla leaf miners not reaching the high population levels observed in controlled pond experiments is larval and pupal parasitism by the native parasitoid *Trichopria columbiana* Ashmead (Hymenoptera: Diapriidae). Field studies have shown pupal parasitism rates exceeded 30% at sites in Texas (Grodowitz et al. 2004, Grodowitz et al. 1997) and were over 19% at sites in Florida and Texas during later studies (Coon et al. 2014). In North America, the genus *Hydrellia* is represented by 55 native species (Deonier 1971), and at least seven of these (13%) are reported as hosts for *T. columbiana* (Coon et al. 2014). The attack of the introduced hydrilla leaf miner by *T. columbiana*, or another specialist parasitoid of native *Hydrellia* spp., was predictable (Buckingham and Okrah 1993), because hydrilla leaf miners were not released in an "enemy-free space" (Lawton 1985).

Established biocontrol agents also are not immune from infection by native disease organisms that can reduce their effectiveness. For example, a microsporidian of the genus *Nosema* was recently discovered infecting the two *Neochetina* weevils that were introduced in the United States during 1970s for biological control of waterhyacinth[*Eichhornia crassipes* (Mart.) Solms] (Rebelo and Center 2001). The disease organism reduces adult survival by 30% and reproduction by 67% (Core 2004). This would explain why the weevils' impact diminished over time.

TECHNICAL FACTORS

Successful establishment of an insect biological control agent can be related to the type of release (caged vs. open), the number and stage of the insect released (Harley and Forno 1992, Buckingham 1994, Cuda et al. 2008), and dispersal capability of the insect. Open field releases enable insects and their progeny to select plants and microhabitat conditions conducive to their survival but they may disperse too widely, which precludes mating and increases the risk of predation (Buckingham 1994). On the other hand, caged releases afford protection from predators and increase the chances of successful mating and recovery of subsequent progeny to confirm establishment (Buckingham 1994).

To promote rapid establishment of biocontrol agents, several releases of large numbers (hundreds of individuals) at the same site is better than a large number of small releases (tens of individuals) (Harley and Forno 1992). Releases of small numbers of a biocontrol agent are more susceptible to establishment failure due to low genetic diversity (e.g., Allee effect), a preponderance of males that limits reproduction, and local habitat changes. The more release sites that are available, the greater the chances of ensuring establishment of a biocontrol agent in the event of unforeseen natural or man-made disasters.

The stage of the insect to be released can be important as well. For example, open releases of only the egg stage of the hydrilla leaf miner failed to establish the insect (Center et al. 1997). However, establishment eventually occurred when the release method was changed to caged releases of late instar larvae. Apparently, eggs and early instars of hydrilla leaf miners experienced higher mortality rates in comparison to later instars. A good rule of thumb is to try all release methods until an effective one is identified to increase the likelihood of establishment (Buckingham 1994).

Biocontrol agents with limited powers of dispersal should be released onto every accessible weed infestation. A good example is the highly successful South American weevil

(*Cyrtobagous salviniae* Calder and Sands) (Coleoptera: Curculionidae) that was released to control giant salvina (*Salvinia molesta* D.S. Mitchell) (Harley and Forno 1992).

Quality-control studies should be conducted during mass rearing programs for established populations of a biocontrol agent. For instance, short-term cold storage (refrigeration) of the egg stage of the hydrilla midge (*Cricotopus lebetis* Sublette) (Diptera: Chironomidae) was used to retard or delay development for transportation to field sites. However, larval hatch rate and adult emergence from the pupal stage decreased significantly after the eggs were held in cold storage for only 2 d (Baniszewski et al. 2015). Therefore, if refrigeration is unavoidable, then the number of eggs released should be increased to compensate for cold-induced mortality.

CONCLUSIONS

The prospects for integrating biological controls with conventional control tactics as well as revegetation (plant competition) are excellent (Cuda et al. 2008). Laboratory and field studies have demonstrated the successful integration of herbicides, insects, and pathogens for controlling a variety of riparian, floating, and submersed aquatic plants (Cuda et al. 2008, Cuda et al. 2016, Gillett-Kaufman et al. 2014, Tipping et al., in press). Some biocontrols can even enhance the effectiveness of herbicides by reducing contact times or number of applications (Netherland and Shearer 1996, Shearer and Nelson 2002).

To maintain sufficient densities of insect biocontrol agents when applying herbicides, it is imperative to provide untreated refuge areas, either by not spraying some sites or by treating them when the biocontrol agent is less active (Haag and Buckingham 1991, Haag and Habeck 1991, Julien and Storrs 1996, Center and Dray 2010). However, this practice may not be required for some biocontrols like the sap-feeding bug *Megamelus scutellaris* Berg (Hemiptera: Delphacidae), a new waterhyacinth biocontrol agent released in 2010 (Tipping et al. 2014). Unlike the *Neochetina* weevils whose larvae feed internally and cannot escape the plants after herbicide treatment, *M. scutellaris* may be more adaptable to chemical control practices in highly managed systems because of its mobility (Yao 2010).

More research is needed on integrating biological controls with plant competition for large-scale management of hydrilla in Florida because of herbicide resistance (Michel et al. 2004, Giannotti 2013). Results of outdoor tank studies indicate that selective herbivory by two established biocontrol agents (Center et al. 1997, Center et al. 2013), can shift the competitive balance in favor of eelgrass (*Vallisneria americana* Michx.), a commonly occurring native species frequently associated with hydrilla (Van et al. 1998). In order for native plants to compete successfully with hydrilla, in most cases they must be well established at the same time as, or prior to, the hydrilla invasion to be competitive (Smart et al. 1994, Van et al. 1999). New technology such as the development of eelgrass "sod" is now being used in lake restoration projects (Gettys and Haller 2012). The large-scale adoption of eelgrass sod not only can increase the establishment rate and expansion of eelgrass, but perhaps also increase its ability to competitively displace hydrilla that has been weakened by biocontrol agents (Grodowitz et al. 2000).

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LITERATURE CITED

Andrewartha HG, Birch C. 1954. The distribution and abundance of animals. University of Chicago Press, Chicago, IL. 793 pp.

Bajwa WI, Kogan M. 1996. Compendium of IPM Definitions (CID) "A Collection of IPM Definitions and their Citations in Worldwide IPM Literature". Integrated Plant Protection Center (IPPC), Oregon State University, Corvallis, Oregon. http://ipmnet.org/IPMdefinitions/defineI.html#60's. (accessed 27 June 2017)

Baniszewski J, Weeks ENI, Cuda JP. 2015. Impact of refrigeration on eggs of the hydrilla tip miner *Cricotopus lebetis*: Larval hatch rate and subsequent development. J. Aquat. Plant Manag. 53:209–215.

Buckingham GR. 1994. Biological control of aquatic weeds, pp. 414–480. In: D. Rosen, F. D. Bennett, and J. L. Capinera (*eds*.). Pest management in the subtropics biological control—A Florida perspective. Intercept Andover, UK.

Buckingham GR, Okrah EA. 1993. Biological and host range studies with two species of *Hydrellia* (Diptera: Ephydridae) that feed on hydrilla. United States Army Corps of Engineers Waterways Experiment Station Technical Report A-93-7, Vicksburg, MS. 58 pp.

Center TD, Dray FA. 2010. Bottom-up control of water hyacinth weevil populations: Do the plants control the insects? J. Appl. Ecol. 47:329–337.

Center TD, Grodowitz MJ, Cofrancesco AF, Jubinsky G, Snoddy E, Freeman JE. 1997. Establishment of *Hydrellia pakistanae* (Diptera: Ephydridae) for the biological control of the submersed plant *Hydrilla verticillata* (Hydrocharitaceae) in the southeastern United States. Biol. Control 8:65–73.

Center TD, Parys K, Grodowitz M, Wheeler GS, Dray FA, O'Brien CW, Johnson S, Cofrancesco A. 2013. Evidence of establishment of *Bagous hydrillae* (Coleoptera: Curculionidae), a biological control agent of *Hydrilla verticillata* (Hydrocharitales: Hydrocharitaceae) in North America? Fla. Entomol. 96:180–186.

Coombs EM, Clark JK, Piper GL, Cofrancesco AF Jr. (*eds*.). 2004. Biological control of invasive plants in the United States. Oregon State University Press, Corvalllis, OR. 448 pp.

Coon BR, Harms NE, Cuda JP, Grodowitz MJ. 2014. Laboratory biology and field population dynamics of *Trichopria columbiana* (Hymenoptera: Diapriidae), an acquired parasitoid of two hydrilla biological control agents. Biocontrol Sci. Technol. 24:1243–1264.

Core J. 2004. Managing disease in beneficial insects. Agric. Res. 52:22–23.

Cornell HV, Hawkins BA. 1993. Accumulation of native parasitoid species on introduced herbivores: A comparison of hosts as natives and hosts as invaders. Am. Nat. 141:847–865.

Cuda JP, Charudattan R, Grodowitz MJ, Newman RM, Shearer JF, Tamayo ML, Villegas B. 2008. Recent advances in biological control of submersed aquatic weeds. J. Aquat. Plant Manag. 46:15–32.

Cuda JP, Shearer JF, Weeks ENI, Kariuki E, Baniszewski J, M. Giurcanu. 2016. Compatibility of an insect, a fungus and a herbicide for IPM of dioecious hydrilla. J. Aquat. Plant Manag. 54:20–25.

Deonier DL. 1971. A systematic and ecological study of Nearctic *Hydrellia* (Diptera: Ephydridae). Smithsonian Institution Press, Smith. Contrib. Zool. 68, Washington, DC. 156 pp.

Forno IW, Julien MH. 2000. Success in biological control of aquatic weeds by arthropods, pp. 161–188. In: G. Gurr and S. Wratten (*eds*.). Biological control: Measures of success. Kluwer Academic, Dordrecht, Netherlands.

Frisbee RE, Luna JM. 1989. Integrated pest management systems: Protecting profits and the environment. Farm Management: The 1989 Yearbook of Agriculture, Washington, DC, p. 226–230.

Gettys LA, Haller WT. 2012. Greenhouse culture of submersed aquatic vegetation "sod". Proc. Fla. State Hort. Soc. 125:386–389.

Giannotti AL. 2013. Hydrilla shows tolerance to fluridone and endothall in the Winter Park Chain of Lakes: Considerations for management strategies and treatment options in urban systems, pp. 5–6. In: 37th Ann. Training Conference, Florida Aquatic Plant Manage. Soc., 2013 Book of Abstracts, St. Augustine, FL.

Gillett-Kaufman JL, Lietze VU, Weeks ENI (*eds.*). 2014. Hydrilla integrated management. UF/IFAS Entomology and Nematology Department, University of Florida, Gainesville, FL. 144 pp.

Grodowitz MJ, Center TD, Cofrancesco AF, Freedman JE. 1997. Release and establishment of *Hydrellia balciunasi* (Diptera: Ephydridae) for the biological control of the submersed aquatic plant *Hydrilla verticillata* (Hydrocharitaceae) in the United States. Biol. Control 9:15–23.

Grodowitz MJ, Doyle RD, Smart RM, 2000. Potential use of insect biocontrol agents for reducing the competitive ability of *Hydrilla verticillata*. U.S. Army Corps of Engineers Research and Development Center ERCD/EL SR-00-1., Vicksburg, MS. 26 pp.

Grodowitz, MJ, Smart M, Doyle RD, Owens CS, Bare R, Snell C, Freedman J, Jones H. 2004. *Hydrellia pakistanae* and *H. balciunasi*, insect biological control agents of hydrilla: Boon or bust?, pp. 529–538. In: J. M Cullen, D. T. Briese, D. J. Kriticos, W. M. Lonsdale, L. Morin, and J. K. Scott (*eds.*). Proc. XI International Symposium on Biological Control of Weeds. CSIRO Entomology, Canberra, Australia.

Haag KH, Buckingham GR. 1991. Effects of herbicides and microbial insecticides on the insects of aquatic plants. J. Aquat. Plant Manag. 29:55–57.

Haag KH, Habeck DH. 1991. Enhanced biological control of waterhyacinth following limited herbicide application. J. Aquat. Plant Manag. 29:24–28.

Harley KLS, Forno IW. 1992. Biological control of weeds: A handbook for practitioners and students. Inkata Press, Melbourne, Australia. 74 pp.

Hoffmann JH. 1995. Biological control of weeds: The way forward, a South African perspective, pp. 77–89. In: Weeds in a Changing World 64: Proceedings of the International Symposium on British Crop Protection Coun., Brighton, UK.

Julien M. 1997. Success, and failure, in biological control of weeds, pp. 9–15. In: M. Julien and G. White (*eds.*). Biological control of weeds: Theory and practical application, ACIAR Monograph No. 49. ACIAR, Canberra, Australia.

Julien MH, Storrs MJ. 1996. Integrating biological and herbicidal controls to manage *Salvinia* in Kakadu National Park, northern Australia, pp. 445–449. In: V. C. Moran and J.H. Hoffmann (*eds.*). Proceedings of the IX International Symposium on Biological Control of Weeds. University of Cape Town, Rondebosch, South Africa.

Julien M, White G. (*eds.*). 1997. Biological control of weeds: Theory and practical application, ACIAR Monograph No. 49. ACIAR, Canberra, Australia. 192 pp.

Lawton JH. 1985. Ecological theory and choice of biological control agents, pp. 13–26. In: E. S. Delfosse (*ed.*). Proceedings of the VI International Symposium on Biological Control of WeedsAgriculture Canada, Ottawa.

McFadyen R, Jacob HS. 2004. Insects for the biocontrol of weeds: predicting parasitism levels in the new country, pp. 135–140. In: J. M. Cullen, D. T. Briese, D. J. Kriticos, W. M. Lonsdale, L. Morin, and J. K. Scott (*eds.*). Proceedings of the XI International Symposium on Biological Control of Weeds CSIRO Entomology, Canberra, Australia.

Michel A, Arias RS, Scheffler BE, Duke SO, Netherland MD, Dayan FE. 2004. Somatic mutation-mediated evolution of herbicide resistance in the nonindigenous invasive plant hydrilla (*Hydrilla verticillata*). Mol. Ecol. 13:3229–3237.

Minteer CR, Tipping PW, Knowles BK, Valmonte RJ, Foley JR, Gettys LA. 2016. Utilization of an introduced weed biological control agent, *Megamelus scutellaris*, (Hemiptera: Delphacidae) by a native parasitoid. Fla. Entomol. 99:576–577.

Netherland MD. 2014. Chapter 11: Chemical control of aquatic weeds, pp. 71–88. In: L. A. Gettys, W. T. Haller, and D. G. Petty (*eds.*) Biology and control of aquatic plants: A best management practices handbook. 3rd ed. Aquatic Ecosystem Restoration Foundation, Marietta, GA.

Netherland MD, Shearer JF. 1996. Integrated use of fluridone and a fungal pathogen for control of hydrilla. J. Aquat. Plant Manag. 34:4–8.

Newman RM. 2004. Invited review—Biological control of Eurasian watermilfoil by aquatic insects: Basic insights from an applied problem. Arch. Hydrobiol. 159:145–184.

Paynter Q, Fowler SV, Gourlay AH, Groenteman R, Peterson PG, Smith L, Winks CJ. 2010. Predicting parasitoid accumulation on biological control agents of weeds. J. Appl. Ecol. 47:575–582.

Rebelo MT, Center TD. 2001. Microsporidia and Neochetina. Water Hyacinth News (October) 4:5–7.

Rosen D, Bennett FD, Capinera JL. (*eds.*). 1996. Pest management in the subtropics integrated pest management—A Florida perspective. Intercept, Andover, UK. 510 pp.

Shabana YM, Cuda JP, Charudattan R. 2003. Combining integrated control of hydrilla with plant pathogenic fungi and the leaf-mining fly, *Hydrellia pakistanae*, increases damage to hydrilla. J. Aquat. Plant Manag. 41:76–81.

Shearer JF, Nelson LS. 2002. Integrated use of endothall and a fungal pathogen for management of the submersed macrophyte *Hydrilla verticillata* (L.f.) Royle. Weed Technol. 16:224–230.

Smart RM, Barko JW, McFarland DG. 1994. Competition between *Hydrilla verticillata* and *Vallisneria americana* under different environmental conditions. Army Engineer Waterways Experiment Station Environmental Lab Publ. No. WES/TR/EL-A-94-1, Vicksburg MS.

Tipping PW, Gettys LA, Minteer CR, Foley JR, Sardes JR. 2017. Herbivory by biological control agents improves herbicidal control of waterhyacinth (*Eichhornia crassipes*). Invasive Plant Sci. Manag. 10:271–276.

Tipping PW, Sosa A, Pokorny N, Foley J, Schmitz DC, Lane JS, Rodgers L, McCloud L, Livingston-Way P, Cole MS, Nichols G. 2014. Release and establishment of *Megamelus sculellaris* (Hemiptera: Delphacidae) on waterhyacinth in Florida. Fla. Entomol. 97:804–806.

University of Florida Extension. 2006. IPM Florida. http://ipm.ifas.ufl.edu/index.shtml. (accessed 24 June 2017)

Van TK, Wheeler GS, Center TD. 1998. Competitive interactions between hydrilla (*Hydrilla verticillata*) and vallisneria (*Vallisneria americana*) as influenced by insect herbivory. Biol. Control 11:185–192.

Van TK, Wheeler GS, Center TD. 1999. Competition between *Hydrilla verticillata* and *Vallisneria americana* as influenced by soil fertility. Aquat. Bot. 62:225–233.

Van Wyk E, Van Wilgen B. 2002. The cost of water hyacinth control in South Africa: A case study of three options. Afr. J. Aquat. Sci. 27:141–149.

Vogt GB, Quimby PC, Kay SH. 1992. Effects of weather on the biological control of alligatorweed in the lower Mississippi Valley region, 1973–83. U.S. Department of Agriculture Tech. Bull. 1766, Washington. D.C. 143 pp.

Yao S. 2010. Scientists release biocontrol for water hyacinth. USDA/Agricultural Research Service. ScienceDaily (May 18, 2010). www.sciencedaily.com/releases/2010/05/100518121631.htm. Accessed June 23, 2017.