Is biological control of weeds better than herbicides?

Biological control (biocontrol for short), when applied in the broadest sense, involves the use of animals, insects, fungi or other microbes to feed upon, parasite or otherwise interfere with a targeted pest species. Classical biocontrol targets a non-native pest (e.g. alien invasive weeds) for control by one or more species of biocontrol agents (e.g. insects, pathogens) from the pest’s native range.

Classical biocontrol remains the most popular and successful approach for controlling alien invasive weed species the world over. Fundamental to the success of biocontrol as a practice, is the 100% host specificity required of biocontrol agents – an attribute that is supposed to protect against harmful effects on non-target species and ecosystems.

More readily accepted

Following several decades of intensive use of synthetic chemicals (herbicides, insecticides, fungicides, bactericides) for crop protection and other purposes, Harris (1991) points to public demand for a shift from chemical to biological control. However, several dilemmas are associated with a change in emphasis from chemical to biocontrol – obstacles in the way of greater adoption of biocontrol range from scientific, legal, political to practical issues.

Therefore, biocontrol is essentially subjected to the same scrutiny as synthetic chemicals, except for the fact that the public, in particular consumers of farm products in developed countries, tends to more readily accept the employment of biocontrol practices for food production than they do chemical control practices.

Regulatory authorities responsible for the registration of agrochemical products, for pesticides in particular, are often perceived by the agrochemical industry to be guided more by public perception (politics) than by the real risks (exposure, toxicity) associated with the use of agrochemicals. Literature abounds with comparisons of the pros and cons of biocontrol compared to chemical control. When the authors are proponents of biocontrol, their approach is often to promote biocontrol as an adversarial or alternative measure in relation to the use of synthetic chemicals.

Undoubtedly, some supporters of the use of pesticides make the same mistake, but fortunately the proponents of integrated pest management (IPM), in which all control practices are considered on an equal footing, still hold sway.

In order to avoid the quagmire of divergent and conflicting opinions, the present discussion will focus solely on salient facts as they apply in practice, with reference to examples of weed biocontrol in South Africa.

Apparent benefits

The benefits of successful control of an alien invasive weed in, for instance, the Kruger National Park through the release of this species’ natural enemies, should be manifestly apparent. Safeguards against non-target harmful effects are vested in the standard procedures that candidate biocontrol agents imported from their natural habitats undergo exhaustive screening for efficacy and 100% host specificity under quarantine conditions.

The rationale for achieving success with biocontrol in natural environments is that non-target plant species, which dominate the plant community, i.e. indigenous vegetation, will take the invader(s) place. Similar logic applies to the control of aquatic alien invasive weeds (e.g. water lettuce, water hyacinth, Kariba weed), except that in this case the taking over by indigenous aquatic plants does not apply, due to the dearth of free-floating aquatic plants in South Africa.

In contrast, in crop production systems, the crop or desirable species is usually a single one that occurs at fixed density, whereas the weed spectrum on
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a particular area can be diverse in terms of weed types and levels of infestation. In such a setting, selective biocontrol of one or even two weed species will hardly make a difference, since individuals of other species already present will simply take their place.

Economies of scale
However, in cases where a particularly noxious (herbicide-resistant, poisonous, extremely competitive, etc.) weed occurs in crop production, it might be practical to employ biocontrol. The basic problem with this kind of biocontrol is that economies of scale will dictate whether the product will have a large enough and sustainable market in order to warrant research and development (R&D) and registration costs.

One bioherbicide product that was discontinued in South Africa for the reason that the market was deemed too small is Hakattač®, which was a formulation containing spores of the fungus Colletotrichum glaucosporioides used for controlling the alien invader tree of Australian origin, silky or needle hakea (Hakea sericea) (Morris, 1982, 1983). The same fungus is registered in the United States (US) under the tradename LockDown® (Delta Farm Press, 2009) for the control of a rare legume weed species, Aeschynomone virginica (common names: curly indigo; northern jointvetch), which is particularly hard to control in rice with synthetic herbicides. Other fungus-based bioherbicide products registered in the US (year 2000) were the products Smolder® and DeVine® for the control of the parasitic weed dodder (Cuscuta sp.).

I am unaware of any bioherbicide product currently registered in South Africa for weed control. In this country, there are several success stories on the biocontrol of alien invader weeds occurring in natural (e.g. conservation areas) or seminatural (e.g. game farms) habitats.

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According to Moran et al. (2011), certain target weeds that have been successfully controlled biologically include the following species: several cactus species (e.g. the prickly pear, Opuntia ficus-indica), St John’s wort (Hypericum perforatum), sesbania (Sesbania punicea), the aquatic weeds water fern (Azolla filiculoides), kariba weed (Salvinia molesta) and water lettuce (Pistia stratiotes).

Continuing research
It should be borne in mind that eradication of these weeds has not been achieved, nor was it the aim. Consequently, they can occasionally be problematic in certain locations. Research by the Agricultural Research Council – Plant Protection Research Institute on these and many other targets for classical biocontrol is underway and continuous.

Cover crop or so-called ‘smother crop’ practices provide a type of non-classical biocontrol of weeds. By means of this practice, certain attributes of the crop are employed for weed suppression, and cover cropping is a key component of conservation agriculture.

Live crops and residual (dead) plant material are used to withhold light from weed seeds, thereby preventing or reducing germination. Biochemical compounds called allelochemicals, which are released from live and dead crop plants in the phenomenon of allelopathy, inhibit the germination, growth and development of weeds.

Although it is generally accepted that the use of synthetic herbicides will remain the mainstay of weed control programmes long into the future, it is imperative that we consider the alternative weed management options available. An integrated approach to weed management is crucial for sustainable crop production. In all instances, all the available weed control options deserve consideration in designing a weed management strategy that offers the best chance of contributing to maximise farmer profits and the achievement of optimal yields of safe and sufficient food.