

LETTER TO EDITOR

Is biological control using seed-reducing agents
a waste of time?**Brian W. van Wilgen^{1*}** , **David M. Richardson¹** , **Guy F. Midgley¹** , and
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The ecological and socio-economic impacts of invasive alien species are demonstrably substantive at the global level and may be locally devastating.¹ Scientific evidence lies at the heart of effective approaches to combating this well-recognized problem. Given the associated costs, it is crucial to develop and test these solutions with careful consideration of the risks involved. On this basis, we wish to counter the premature conclusion of the recent paper by Veldtman and Strydom² on assessing the effectiveness of Australian *Acacia* biological control in South Africa. The study used primarily seed-reducing agents and concluded that the seed-reducing biocontrol program on these plants is a wasted effort.

Biological control is one of the few interventions that can lead to a permanent improvement in the state of biodiversity in ecosystems under severe invasion pressure.³ In the case of plant invasions, where physical control is costly, biological control has offered an effective and affordable means to reduce the viability of invasive populations, and thus significantly increase the effectiveness of physical control efforts. We not only criticize here the conclusion of Veldtman and Strydom as premature and arguably irresponsible, but also propose that their valuable work could be far more productively framed.

Veldtman and Strydom's paper points out, correctly, that pre-treatment baselines and monitoring data are necessary to accurately gauge the effectiveness of control interventions.² This has, in fact, been done in the case of Australian acacias in South Africa within the limits of resources available. Veldtman and Strydom's work has demonstrated that, in some situations, there is still an abundance of seed despite the application of biological control. The problem is that confining any assessment to this one consideration ignores the bigger picture and, therefore, invalidates any assumptions that biological control is not working. The obvious patterns of change that have happened since biological control was initiated on Australian *Acacia* species in South Africa provide evidence that unquestionable benefits have ensued, and continue to do so, from deploying seed-reducing and other agents against the invasive *Acacia* species. Some additional aspects are outlined below.

We concede that a plant population may persist on a site in the presence of seed-reducing biological control agents. However, it should be recognized that dispersal from that site is a function of the number of seeds produced,^{4,5} and that shorter dispersal distances will reduce the rate of spread to new sites. This, in turn, will increase the effectiveness of physical control efforts. There is a threshold in terms of control effort that needs to be reached before the spread can be reversed.⁶ When seed production is

***Corresponding author:**Brian W. van Wilgen
(bvanwilgen@sun.ac.za)**Citation:** van Wilgen BW, Richardson DM, Midgley GF, Holmes PM. Is biological control using seed-reducing agents a waste of time? *Explora Environ Resour.* 2025;2(4):025140028.
doi: 10.36922/EER025140028**Received:** April 1, 2025**Accepted:** August 18, 2025**Published online:** September 3, 2025**Copyright:** © 2025 Author(s). This is an Open-Access article distributed under the terms of the Creative Commons Attribution License, permitting distribution, and reproduction in any medium, provided the original work is properly cited.**Publisher's Note:** AccScience Publishing remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

reduced, that threshold will be lower, and therefore more affordable and attainable. There are also two independent data sources, one from roadside surveys and the other from remote sensing, showing that populations of Australian acacias under biological control have contracted,^{7,8} or spread relatively less than other invasive plants at a national scale in South Africa. These findings are supported by other extensive, thorough, long-term monitoring projects.^{9,10}

Reducing the number of seeds can also reduce the invasive potential of an introduced species. The success of invasive species is enhanced by post-introduction evolution.¹¹ Substantial reductions in the numbers of seeds produced will correspondingly reduce the effectiveness of this selective pressure, again assisting control efforts.

Interactions between alien and indigenous plants, as well as granivorous species, also need to be considered. Using *Acacia saligna* as an example, seed bank dynamics are substantially affected by stand density and the impact of seed consumption by rodents. While rodents consume significant numbers of *A. saligna* seeds, the rodents avoided closed canopy stands before the introduction of the pathogenic fungus *Uromycladium morrisii*. Dense stands that existed before the introduction of the fungus led to the extirpation of indigenous plants.¹² Following the introduction of *U. morrisii*, the stand density and canopy cover of *A. saligna* have declined, and rodents now consume more seeds. In addition, the relatively open canopies allow the persistence of some indigenous plants and the ongoing replenishment of their seed banks. Biological control has thus made it possible for indigenous species to re-establish after physical clearing,^{13,14} a factor that was not considered by Veldtman and Strydom.

In South Africa, the decision to restrict biological control to seed-reducing agents was made to protect plants with commercial value.¹⁵ Some seeds will always survive, and Veldtman and Strydom suggest that drastic reductions in seed production (>99%) may be necessary to prevent the persistence of acacias on a particular site. This point is considered, but one of the largest management problems is dealing with the massive regeneration of seedlings from soil-stored seed banks after fires. A substantial reduction in seed production, achieved using biological control, will almost certainly reduce this effort, again making physical control possible where it would otherwise not have been. We contend that if we had introduced the seed-feeding biological control agents when the trees were first introduced, the massive seed banks would likely not have developed, and the problem would have been easier to manage. As the use of Australian *Acacia* trees is growing around the world,¹⁶ it would be important to try to reduce the invasion debt that this is causing. We

therefore recommend seed-reducing biological control as a practical, proven technology to assist with this. Such a practice could, for example, be incorporated into global guidelines for the use of non-native trees.¹⁷

We acknowledge shortcomings in the historic assessment of control effectiveness. However, in South Africa, studies have been conducted on multiple sites with several species for over 20 years.^{10,18} To justify the conclusion that seed-reducing agents are not effective in helping to control Australian *Acacia* species, it would be necessary to provide more convincing evidence than Veldtman and Strydom's current limited study of seed banks in predetermined, but not necessarily representative, sites (e.g., they only studied sites where the acacias were abundant, with closed canopies, only considered intra- and not inter-species competition and interactions, and did not consider impacts on spread from the site). What is needed is an evaluation of efficacy in the context of what would have happened if the intervention had not been there (i.e., a counterfactual study at a landscape scale).¹⁹

We must also guard against the implied general conclusions that biological control is not warranted. For example, Veldtman and Strydom list one of the "consequences" of (in their view, unwarranted) support for biological control as "more investment into biological control in South Africa." This is not a negative consequence and ignores the fact that biological control has brought numerous problematic species under control, not only in South Africa but globally, and that biological control is the only management intervention that has resulted in declines in such species when assessed at a national scale.^{7,8} Further investment in biological control in South Africa and elsewhere globally would therefore bring significant benefits to ecosystems and society. Veldtman and Strydom's work has provided additional insights into some of the dynamics of invasive alien plant populations as affected by biological control. However, it would be far more constructive to pool their findings with those of others within a broader framework than to condemn the exercise as a "waste of effort."

Conflict of interest

The authors declare that they have no competing interests.

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