Weed Risk Assessments Are an Effective Component of Invasion Risk Management

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Smith et al. (2015) recently proposed that weed risk assessment (WRA) systems "are unable to accurately address broad, intraspecific variation and that species introduced for agronomic purposes pose special limitations." This conclusion is drawn from their application of the Australian (A-WRA) and U.S. (US-WRA) weed risk assessment (WRA) systems to evaluate proposed bioenergy crops, cultivated crops, and known invasive nonnative plants. We do not believe that this conclusion is robust and question the approach and outcome of their comparative study. Our view is that this study misrepresents the utility of WRA tools and, more broadly, might potentially hinder efforts to

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evaluate the invasion risk of nonnative plant species. Here we describe four key issues that limit the conclusions of the Smith et al. (2015) study.

First, the assertion that WRAs cannot evaluate subspecific taxa ignores the many applications of both the A-WRA and US-WRA to hybrids, cultivars, and intraspecific taxa (Barney and DiTomaso 2008; Gordon et al. 2011; Koop et al. 2012). For example, Smith et al. (2015) do not distinguish between the crop, sorghum [*Sorghum bicolor* (L.) Moench], and its known invasive subspecies [shattercane: *S. bicolor* ssp. *drummondii* (Nees ex Steud.) de Wet and Harlen]. Instead, they combined data from both the crop and the known invader, thereby biasing their risk scores to argue that WRAs cannot parse nonproblematic crops from invasive species. Failing to distinguish among subspecific taxa in their assessments despite clear guidance to assess only the specific taxon of interest (Gordon et al. 2010; Plant Protection and Quarantine 2015) and precedents for subspecific assessments (e.g., Davis et al. 2010; Gordon et al. 2011) invalidates their conclusion that WRAs cannot account for variation within species. The Smith et al. (2015) argument is circular: the authors unnecessarily included data reflecting intraspecific variation, and then concluded that the risk assessment tools failed because of the inclusion of intraspecific variation.

Second, not all agronomic weeds become "invasive," a point clouded in Smith et al. (2015) because the authors do not clearly define "invasive" in the context of their study. Here, we rely on the standard definition of an invasive species as "an introduced species that has spread well beyond its arrival point and that perpetuates itself without human disturbance" (Simberloff 2013). Smith et al. (2015) are correct in claiming that evidence of "weediness" elsewhere can be a major determinant of high scores in WRAs (Hulme 2012), but are misleading in not clearly considering the different interpretations of the term "weed" in the agronomic and ecological literature (Pyšek et al. 2004). Smith et al.'s (2015) risk assessments would be confounded if prior evidence of crops as agronomic weeds were interpreted as invasiveness outside of cultivation or highly anthropogenic habitats.

Third, the criticism that WRAs cannot be used as a "singular argument of risk management" misinterprets how WRAs are used in practice. In fact, multiple authors have stressed the desirability of a multitiered approach that follows the WRA with modeling and experimentation, as well as the need to consider whether management practices could mitigate risk (e.g., Davis et al. 2010; Flory et al. 2012; Leung et al. 2012). Risk assessment is recognized to provide a preliminary screening approach that can be used to determine: (1) if additional evaluation is warranted; (2) whether breeding or other genetic modification (Barney and DiTomaso 2008) or Best Management Practices that reduce risk can be identified; or (3) whether other management is needed to reduce the probability of escape and invasion (Quinn et al. 2015). The results from experimental trials and other key information pertinent to proposed cultivation, such as number, area, and spatiotemporal distribution of plantations (i.e., propagule pressure), should be incorporated into full risk management evaluations associated with taxa cultivated for bioenergy or other purposes. Thus, we agree with Smith et al. (2015) that WRAs are but one component of risk management, and cost–benefit considerations are also relevant. We find incorrect, however, Smith et al.'s (2015) suggestion that current WRAs are ineffective because they are not comprehensive risk management tools.

Finally, other assertions and inconsistencies in the application of both the US- and A-WRAs are evident in the Smith et al. (2015) study. These range from unexplained use of the secondary screen for the US-WRA but not for the A-WRA, to criticisms of subjective rather than data-based assessment, to lack of clarity on the criteria and sources for the data used (e.g., whether data from the United States were excluded for the analysis as has been consistently employed in other WRA validation efforts [Koop et al. 2012]). In addition, Smith et al. (2015) present neither the WRA numerical scores nor their underlying data. As a result, sources of results inconsistent with published WRAs on the same species (e.g., Quinn et al. 2015) cannot be evaluated. Collectively, these issues reinforce our contention that the conclusions of Smith et al. (2015) are nontransparent and potentially misleading.

In summary, the Smith et al. (2015) conclusion that WRAs are ineffective is misleading because it relies on a circular argument about intraspecific variation, is confounded by an unclear definition of "weediness," suggests that risk assessment tools are intended as the only component of invasion risk management, and applies WRA tools in ways that are inconsistent with current guidelines for their use. Their conclusions run contrary to the many other more rigorous evaluations of WRA in the scientific literature and the strong evidence that WRA has utility for practical applications. Consequently, we strongly disagree with Smith et al.'s (2015) argument and affirm the use of WRA as a critical component of the invasive plant prevention toolkit.

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