Weed Science

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A unifying approach for IWM

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My view

Cite this article: Young SL (2020) A unifying approach for IWM. Weed Sci. **68**: 435–436. doi: 10.1017/wsc.2020.60

Received: 18 July 2020
Accepted: 21 July 2020
First published online: 26 August 2020

Associate Editor:
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Over the past several decades, interest has been growing in cover crops, which has led to adoption primarily in cropping systems of high-rainfall regions and further testing in areas with less favorable growing conditions. While the focus of cover crops has been predominantly on improving soil health, by comparison, a small number of studies have diverted to the narrower subject of weed management and this is, arguably, changing the approach to integrated weed management (IWM).

It is by no accident that cover crops, in the traditional sense, make for good weed control, as plant competition is the basis. This fundamental principle is at the very heart of weed science. The critical period (of weed control) relies on an understanding of how plants compete for limited resources. As weeds remain uncontrolled for longer durations, the crop suffers from decreased access to water, nutrients, and light, which causes a reduction in growth and ultimately lower reproduction (i.e., yield). The use of cover crops specifically for controlling or outcompeting weeds has begun to move the field of weed science in a direction that could serve as the bridge for greater incorporation of IWM across all cropping systems.

In agriculture, plants are the focus and weed science is the one pest discipline that is different from entomology and plant pathology in that weeds are akin to the crop with regard to basic morphology, biology, and physiology. The very definition of a weed—"a plant growing out place"—is, again, related to competition, leading to differences in growth rates and reproduction. IWM is the use of multiple tools that gives one plant (crop) a competitive advantage over and usually at the expense of another (weed). The use of cover crops is less well understood as an IWM tool, but new studies, both applied and basic, are promising and leading to advances in crop production. Along the way, this approach, as it continues to evolve, could unify IWM across the weed science discipline.

The role of plants in IWM is viewed either positively (crops) or negatively (weeds). Often the emphasis has been on the total elimination of weeds and for good reasons, such as depleting the soil seedbank, avoiding the harboring of insects and diseases, and improving harvest efficiency. However, new cover crop– or plant-based IWM approaches are bringing plants back into the equation based on the fundamental principle of competition. In regions with adequate rainfall or available irrigation, cover crops used at the proper time and correct seeding rates are providing weed control through competition. This is in contrast to herbicide-based IWM, which relies primarily on chemistry and thus results in bare ground and often reinfestations that must be treated again (and again).

While there is economic gain for both plant-based and chemical-based IWM, the benefits to natural resources are greater for the approach that emphasizes cover crops. And as cover crops could be considered a big hammer (Liebman and Gallandt 1997), similar to herbicides, the side effect of off-target movement is eliminated. Still, without careful selection and use, the main drawback is the potential for a cover crop to become a weed.

IWM at its core is integration, and thus elements of the plant-based and chemical-based approaches can be selected and merged for any crop in a variety of situations. Philips et al. (2014) describe the IPM (Integrated Pest Management) continuum as a scale ranging from low to medium to high to biointensive based on the number and type of management practices employed. In a plant-based IWM continuum, at the simplest of levels (low), cover crops would be limited in space or to select crops and only used periodically at specific time points in an annual or multiyear rotation. At the most intensive level (high), cover crops would be the main tool used as a complete cover in all crops continuously year-round. Moving from low to high levels on a plant-based IWM continuum would be similar to the IPM continuum, in that there would be less use of herbicides alone (low) up to an increased understanding of the crop system and how to best employ cover crops for weed control (high).

Plant-based IWM is applicable for all cropping systems, but research is needed. For example, in organic crops, cover crop termination can be challenging, especially when wet weather conditions persist for long periods. In arid regions, a long-standing debate exists as to whether the benefits of cover crops outweigh their consumption of precious soil moisture reserves. In semi-arid and arid regions, soil moisture is at a premium, and without irrigation, only the most finely tuned operation can successfully incorporate the use of cover crops for weed control. In some, if not most years, using cover crops in rainfed cropping systems of arid regions is just not possible. However, research is still being conducted in these dry regions to test not only drought-tolerant crops, but cover crop species, as well. Climate change and the onset of extreme events warrant

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continuing this area of research. Finally, cover crop interference with harvest operations is a legitimate concern in a plant-based IWM approach. Like weeds, cover crops can create havoc in a crop of wheat or corn if allowed to reach heights that foul equipment or densities that slow machinery and make it difficult to determine the crop from cover crop. Research is needed to identify cover crop species specific to crops that account for morphological and physiological features. In addition, research needs to be conducted on the specificity of the region for which a cover crop is best suited. Species that thrive in high-rainfall areas or heavy clay soils may not be a universal fit for all systems in every region.

The potential for unifying IWM across the field of weed science is now possible with the increasing interest in and research on cover crops for controlling weeds. There is still much to learn, and many more studies are needed in order to know how best to use cover crops in a plant-based IWM approach, but there is a movement to address these gaps within the field of weed science. As cover crops for weed control continue to be adopted and grower interest widens, ongoing and new research that addresses the key challenges of a plant-based approach will help unify IWM.

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https://doi.org/10.1017/wsc.2020.60 Published online by Cambridge University Press