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My view

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Public attitude associated with use of pesticides and other agricultural inputs has placed increased emphasis on development of ecologically based pest management (EBPM). One reaction of the Weed Science discipline has been to call for increased research on the basic biology and ecology of weed species in hopes that the "Achilles heel" of each weed can be discovered and exploited to reduce reliance on management with herbicides and other environmentally invasive practices. The implicit assumption in this approach is that natural weed population-regulating mechanisms can be augmented and then used as management prescriptions integrated with some minimized use of conventional practices (herbicides, tillage, etc.). The underlying logic of this approach is commendable, but the assumption that we can turn ecological responses in weed populations into prescriptions for management in the same way that we prescribe herbicides, is critically flawed. We will doom the implementation of EBPM if weed scientists do not recognize the fundamental difference between herbicide- and ecological-based weed management.

Herbicides overwhelm a biological system with mortality, often at a single stage in the life cycle of the pest. This effectively squashes the current and future variation in the pest population if the herbicide is continuously used. A basic premise of EBPM is to impose multiple and more subtle impacts on biological processes that maintain pest population dynamics at a new lower equilibrium. I propose that subtle manipulation of biological processes to manage pests may be possible, but it is often not recognized that this approach, when applied in most conventional crop production systems, will produce unpredictable responses in pest populations and subsequent crop effect during the early stages of conversion from conventional management. If the typical length of our experiments continues to be only 2 to 3 yr, then we may only see the stage in EBPM where the pests are raging out of control, because of the release from major mortality events. Organic growers have observed that conversion from conventional pest management is extremely difficult in the first few years until the system is allowed to rebuild ecological buffering capacity that results in natural pest population-regulating mechanisms.

Natural regulation is complex and therefore often unpredictable, especially in systems with a low ecological buffering capacity. Ecological buffering is thought to be highest in systems with a diversity of species at many trophic levels and many food web connections, allowing for high resiliency and low temporal variability. In the transition from a high-input, monoculture system to a more diverse (multi- or polyculture) cropping system, yield may drop and variance in yield may increase drastically during the early stages of the transition. The decrease in yield would reflect weed population spikes and the lack of natural feedback-regulating mechanisms (i.e., other organisms at all trophic levels) in response to a decrease in pesticide inputs. The high variance would reflect differential rates of increase and nonequilibrium dynamics in the pesticide-influenced populations. Following this hypothesis, as the transition progresses, the variance should slowly decrease, and as pest populations come under increased natural population regulation, yields should increase.

Research and management implications associated with this hypothesis would include: (1) possible false interpretations of systems in transition, and (2) possible false expectations from systems in the early stages of transition. The solution may include long-term (7 to 10 yr) experiments that emphasize the study of variation rather than mean responses in the weed populations. In addition, research that identifies characteristics of ecological refuges within fields to optimize conversion to EBPM and minimize risk associated with unpredictable crop losses during the transition process may be important.

It occurs to me that there are two philosophical approaches to experimentation that can lead to application of EBPM. The first is the reductionist approach, which assumes that only by close scrutiny of the variation and interactions among the pest population-regulating variables, can we hope to identify and predict pest dynamics and thus develop prescriptive management. The second approach relies more on a study of the general patterns of variation and behavior in pest communities and populations in response to general manipulations (e.g., polycultures decrease pest effects relative to monocultures). The latter approach seeks to identify only general concepts, but it is the more effective way to apply EBPM, at least initially.

Weed management scientists and extension specialists must change their research perspective from prescription of short-term annual solutions to concept-based approaches to management. Variability in pest populations under EBPM will doom this alternative approach if it is applied prescriptively. Site-specific approaches to farm field management may offer innovative solutions to understanding and managing around variability, but this leaves the prescriptions to be developed independently by applying the concepts within each field. Our challenge as a discipline is to identify ways to deliver the concepts and provide mechanisms where researchers and crop consultants working directly with the producer can apply the concepts in specific, within-field, management practices. In addition, we must teach our clientele how to ask for concepts rather than prescriptions and let them apply their accumulated site-specific knowledge along with our concepts and data to accomplish EBPM.