

USDA-CSREES Workshop
Research Priorities in Plant and Pest Biology
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Comments of
Weed Science Society of America

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General Current Concerns

- Long-term Strategic Plan for Pest Management
- Bridging Between Agro-Ecosystems and Natural Areas
- Bridging Between Bio-security and Crop Protection
- Geographically Dispersed Expertise and Support for Extension
- Minor Crop and Specialty Use Herbicide Registrations
- Resistance Management

Future Research Directions for Weed Science; Weed Technology, 2000. Vol. 14:647-658
(A recent snapshot of weed science research opportunities, concerns and limitations prepared by the WSSA Research Committee in 2000.)

Synopsis

Knowledge Based and Systems-Approach Based Decision Support Strategies

With the proliferation of computer technology there are good opportunities to build decision aids that integrate data, knowledge and grower wisdom with social, economic and environmental perspectives. To build these systems more long-term, large-scale studies are necessary and growers and advisors must be included in their development. Technology is only one-half of technology adoption.

Weed Biology and Ecology

Better understanding of weed biology and weed ecology is needed to accelerate progress in several areas of weed management such as GIS based variable rate herbicide applications, herbicide resistant crops (HRC) and knowledge based decision support systems. The value of these management tools depends greatly on better understanding of the mechanisms of weed, crop and cropping system interactions. This includes research in weed ecology, genetics and physiology.

Economic treatment thresholds may be one outcome, but we are far from consensus on their feasibility and utility and far from ready to apply them broadly. A major concern is response to selection pressure in the form of herbicide resistance, shifts to new weed species or adoption of a weed species to cultural practices. Weed-crop interactions are extremely complex with multiple weed species interacting differently with each other, with different crops, with varying weather conditions and evolving cultural practices. Long-term, large-scale mechanistic studies are needed.

Invasive weeds

Invasive weeds are an enormous problem that presents both CSREES and WSSA with great opportunities and responsibilities. The response to this problem is in its infancy and the research and education needs are significant. Predictive tools are needed to identify and interdict species of concerns and to detect contaminants in commerce. We need systems for early detection and rapid response (EDRR). We need basic research on the mechanisms of plant invasions and tools to assess impacts on ecosystems, including threatened and endangered species. We need economic assessment tools to quantify the impacts of the problem and to help set management priorities.

Ultimately, management research in new environments is needed to gain practical experience. All types of management strategies including chemical, biological, cultural and mechanical techniques must be researched and integrated with the objective of restoring or maintaining stable systems that resist future plant invasions.

The need for trained people to lead federal, state and private management efforts is also significant. Currently, many staff responsible for leading weed management programs were trained as ecologists, botanists or biologists and lack comprehensive weed management training.

Weed Control and Management

Weed science, by and large, is ultimately very focused on the objective of weed management. Enormous success has been achieved with herbicides in the past sixty years and they will remain the backbone of weed management in all types of environments, setting the standard for efficacy, reliability, predictability, ease of use, low cost and safety. A significant environmental benefit of herbicide use is reduced tillage that results in better air and water quality by reducing wind and water erosion of soils.

Herbicide Resistance

Herbicide resistance is a major concern that warrants significant effort to develop management methods, education programs and public policies. The high cost of product discovery and development is slowing the release of new herbicides so maintaining the efficacy of existing useful compounds is imperative. Research is needed to characterize the mechanisms of resistance, the population dynamics of resistance, the spread of resistance, the fitness of resistant plants and the economic impacts of resistance.

Herbicide efficacy enhancement

With reliance on herbicides it is imperative to continually refine these tools. Doing so will improve response to changing pest problems and public concerns about health and environmental safety. Recent advances have been made through commercial development of low-rate and postemergence herbicides. These herbicides enable overall pesticide use reduction but their efficacy and the risk of spray drift is strongly influenced by application techniques (spray volume, droplet size, adjuvant selection), environmental conditions and the status of the crops and weeds at the time of application. Application technology research to reduce drift and enhance herbicide performance is currently a promising research area. The variable response of crops and weeds according to species, growth stage and environmental conditions also needs further research.

Alternative weed management methods

Alternative weed management methods include cultural practices, mechanical practices, biological agents, natural products, competitive crops, cover and companion crops, mulches, solarization and allelopathy. Alternative weed control often requires combination of multiple methods that only suppress weeds as opposed to providing effective control. The effectiveness and other advantages of herbicides has reduced research on alternative tactics and grower acceptance of the alternatives.

Research on these alternatives is warranted however. Alternative methods offer potential for developing new management options; they will satisfy the major research need of organic growers; they will provide specialty crop growers with options when registered herbicides are unavailable; they will provide resistance management options and they will improve basic understanding of weed-crop interactions.

Biological Approaches

Compared to herbicides biological agents such as mycoherbicides and phytotoxins have limited spectrum of susceptible weed targets. They also lack consistent efficacy and “shelf” stability. Insect agents are more stable and predictable but they also effect limited weed spectrums and are slow acting. These characteristics make biological approaches better suited to natural area weed management than to crop production. Areas of research that will advance biological methods include improved formulations to enhance stability and efficacy, increased knowledge of weed biology and ecology, improved post release monitoring and evaluation of biological agents. Increased empirical analyses of several safety factors associated with biological control is warranted.

Allelopathy is the ability of plants to produce compounds that reduce or alter weed pressure. The major impediments to further use of allelopathy are incomplete understanding of biochemical pathways that produce the compounds, the genes involved and their regulation, and appropriate manipulation of allelopathic plants within cropping systems.

Competitive crop cultivars

Development of cultivars that effectively compete with weeds has been neglected in typical crop breeding programs but this is an area that warrants attention because a crop’s competitive ability to specific weeds can be increased. To do so will require better understanding of competitive mechanisms and their genetic basis.

Cover Crops, Companion Crops, Mulches and Solarization

Cover crops, companion crops and mulches have been widely used in perennial crops but their use in annual and agronomic crops is limited by economic considerations, ease of use and fit with current cropping systems. Research could improve the ease of using these methods in current management systems but it also needs to address concerns about collateral costs on crop performance and associated pest complexes. Solarization is the use of plastic films to raise soil temperatures and control soil borne organisms. There is increasing need for such methods with the loss of some soil fumigants, but wide spread use is limited by disposal requirements and cost considerations

Issues Related to Transgenic Plants and Genomics

Herbicide Resistant Crops (HRCs) were among the first major commercial applications of agricultural biotechnology and this has revolutionized production practices in some crops. Work is continuing with development of resistance to additional herbicides and in additional crops. Much of this work is being performed in the private sector but public sector expertise is also needed to critically evaluate use and risks of this technology, to apply the technology where public benefits may exceed commercial incentives and to apply genomics tools to analyze a broad array of questions in the field of weed science.

Research is needed to examine the impact of HRCs on weed population dynamics and ecology, to quantify the selection pressure for resistant weeds, the impact on future management of resistant weeds and the introgression of transgenes into related species or into non-transgenic crops of the same species. This information will also help in development of models that can guide the appropriate application and regulation of this technology.

Environmental Issues

Herbicide safety

Herbicides are a fundamental and extremely valuable weed management tool and will remain so for the foreseeable future but concerns about human and environmental safety are common. Public sector research is needed both to dispel unwarranted public concerns and to resolve any valid health and environmental problems. Additional research that can increase the margins of safety associated with herbicide use include remote sensing and variable rate site specific application procedures, further development and use of drift reduction techniques and environmental fate and effects simulation models.

Education and outreach are also needed to inform the appropriate audiences about these research results. Worker training is a critical control point to protect against point source contamination and human exposures associated with mishandling or misapplication of herbicides. Human error remains one of the critical causes of health and environmental risk associated with herbicide use.

Effects of weeds and weed management on the environment

Like weed management activities, weeds themselves can affect soil, water and air quality either beneficially or adversely but quantification of these affects is currently inadequate. Federal agencies that are charged with risk benefit analyses, National Environmental Protection Act (NEPA) documentation and Endangered Species Act (ESA) consultations lack adequate information to assess the environmental impact of weeds on ecosystems and threatened and endangered species. Research is critically needed in non-crop and natural areas to determine the impacts of weeds and weed management, to understand habitat and biodiversity changes caused by weed infestations and especially to analyze the impacts of weeds infestations on the protection and recovery of threatened and endangered species.