the national system, international policies and cooperation, information management, and research.

This report offers NPGS a set of guideposts on which it can gauge its success. Increases in federal spending will be required to implement many of the report's recommendations. Others will require no increase in spending. All that is required to implement these recommendations is careful planning and continued commitment to NPGS.

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PATHOGENS AS PESTICIDES


The concept of using microbial plant pathogens for biological control of weeds dates from at least the late 1800s. However, while entomologists in the mid-1900s were busy controlling prickly pear and Klamath weed by introducing weed-feeding insects, little sustained effort was made to develop the use of plant pathogens until the late 1960s and early 1970s. Then a flurry of activity started, resulting in introduction of several pathogens into foreign countries in attempts to reduce weed populations (the classical approach to biocontrol) and commercialization of a few for use in an inundative fashion within their country of origin (the bioherbicide or mycoherbicide approach). Concepts and procedures of this endeavor were comprehensively reviewed in a book (based on a 1980 workshop) by Charudattan and Walker (1982).

As Microbial Control of Weeds makes clear, the flurry of activity has continued and the database on weed pathogens has increased considerably, although most of the ideas were present in the earlier reviews. An exception is the concept of genetically engineering weed pathogens for enhanced effectiveness and safety. Ten years ago, this possibility seemed far-fetched, but there has been enough progress (albeit not with weed pathogens) that we can now believe that this technique may come to fruition in the not-too-distant future.

The opening chapters review the status of the classical approach and the mycoherbicide approach. The mycoherbicide chapter in particular makes a commendable attempt to quantify progress since 1982; although there are no new commercial products, a number of pathogens have undergone detailed study, many apparently have been discarded, but a few appear close to commercialization. This section also contains chapters on nematodes as weed control agents and on manipulation options for plant pathogens intended for classical control of weeds, material that could have been integrated easily into the initial classical-approach chapter.

A section on host-parasite interactions includes discussions of host-specificity testing (a major impediment, especially for classical biocontrol), ecology and epidemiology of weed pathogens, and a thought-provoking chapter by D. Gabriel on parasitism and host specificity that provides a transition to the section on genetic manipulation. The three chapters on genetic manipulation (of bacteria, of fungi, and by protoplast fusion) are speculative, because there are no actual successes and few experimental results with weed pathogens. They make it clear that worthy goals for strain improvement include not only greater efficacy but also greater safety of genetically engineered strains by incorporating traits that make it impossible for them to survive in nature. Different authors must have had different audiences in mind: the chapter on protoplast fusion contains much more detail on methods than the other two, although little of it has yet been applied to weed control.

The chapters on integration of biocontrol agents with pesticides and on production, formulation, and application are predictable but competitively done. The discussion of submerged fermentation is lucid, practical, well-illustrated, and well-referenced, although the statistical analysis of fabricated data seems overly detailed. It provides details on the economic considerations that have made industries hesitant to enter this field. A more general discussion of economic considerations rounds out the book.

The contributors are generally recognized in their respective fields. I did not see major voids in coverage, although areas that might have received more attention include developments in the regulatory arena, especially with respect to genetically engineered agents, and more explicit comparisons with developments relative to microbial insecticides and biocontrol agents for plant diseases. The editing or the proofreading are sloppy; one regularly runs into typographical and/or grammatical errors, many of which should have been caught by a computer spell-check.

This book is a useful updated review for those making judgments on the future roles of microbial herbicides. Chemicals currently receive a bad press, and there is much emphasis in the popular press, the public at large, and the scientific community on the biological-control alternative. The early successes (De Vine, Collego, Puccinia chondrillina) were somewhat serendipitous and might be likened to the discovery of an early pesticide such as Bordeaux mixture. However, a systematic, large effort has been required to develop the vast array of chemical pesticides currently available, and a similar effort may be needed to make significant progress in biological control. It is not yet clear that such an effort will be forthcoming. It seems likely that, with current technology, microbial herbicides will make only a limited contribution to weed control. Much more work will need to be done before we can evaluate to what extent genetic manipulation may alter this outlook.

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