ALLELOPATHIC INTERACTIONS IN CROP–WEED MIXTURES: Applications for Weed Management

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Abstract—A very important component of the aggressive nature of weeds is allelopathic interference, the full potential of which is just being realized in the management of agroecosystems. Research results are presented which demonstrate the allelopathic interactions involved in a wide range of crop–weed combinations occurring in a great variety of habitats. This includes crops planted in weed control, crops with allelopathic potential, and noncrop plants of beneficial use for weed control as a result of allelopathic interference. Allelopathy can play a beneficial role in multiple cropping systems, crop rotations, and cover cropping. The potential role for allelopathic interactions in the design of biological weed control is proposed.

Key Words—Agroecosystems, allelopathy, weeds, biological control, multiple cropping, living mulch, interference, phytotoxins.

INTRODUCTION

Many studies have been done which demonstrate the allelopathic nature of the effects of weeds on crop growth and development (Tukey, 1969; Putnam and Duke, 1978; Rice, 1974, 1979). In such studies considerable attention has been given to the role of allelopathic interactions between different crop plants or the inhibitory effects of phytotoxins produced by weeds on crops. Relatively little research, on the other hand, has focused on the

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important role allelopathy might play in weed management. By thoroughly understanding the complexity of crop–weed interactions in different agroecosystems, allelopathy might effectively be combined with an array of weed management practices.

In order to utilize allelopathic interference successfully in weed management, it is necessary to find naturally occurring chemical compounds which inhibit seed germination, plant growth, or prevent propagule or fruit production. Such compounds can be useful in many ways, one of the best known is through the manipulation of the crops themselves in an agricultural system. It has been proposed for several years that a crop could be used to “smother” weeds (Overland, 1966). The planting of “smother crops” was often employed in the past to suppress the growth of weeds, although it was most often assumed that such crops inhibited weed growth through competition. Overland (1966) demonstrated that living plants and roots of barley (*Hordeum vulgare*) actively produced and released toxic quantities of organic compounds capable of inhibiting growth of several common crop weeds. Where crop lines have been studied that have coevolved with interference from other plant species, especially weeds, it appears that some are potentially capable of chemical inhibition. Putnam and Duke (1974) screened a large germ plasm of *Cucumis sativus* and related *Cucumis* species and found several which demonstrated allelopathic activity at least in sand culture. Under certain field conditions some cucumber accessions inhibited the growth of several weed species (Lockerman and Putnam, 1979). Fay and Duke (1977) assayed a large number of accessions of *Avena sativa* and found some very strong lines for inhibiting weeds through the active exudation of a mixture of compounds. The importance of crop inhibition of weeds has also been suggested by Bell and Koeppe (1972) and has been very actively studied by several Russian scientists with a wide array of crop–weed mixtures (reviewed in A.M. Grodzinsky, 1971-1977).

Noncrop plants, either associated with the crop species or planted in rotational sequence with them, offer possibilities for allelopathic weed control. By producing toxins effective against weeds, but not harmful for the crop, the association of such plants can be manipulated to considerable advantage. Research at Cornell University aimed at the development of “living mulches” for use with vegetable crops is a good example (Anonymous, 1981). A study of the crop–weed combination of *Linum usitatissimum* (flax) and the weedy *Camelina sativa* showed that the crop plant growth was stimulated by the presence of the weed and, on the other hand, apparently the weed also inhibited the invasion of other weeds through a combination of allelopathic and competitive interference (Lovett and Duffield, 1981). In our studies, we have focused on different aspects of crop–weed interactions, concentrating on those cases where allelopathy might play an important role.