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DO ONE YEAR'S SEEDS REALLY MAKE SEVEN YEAR'S WEEDS?

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Introduction

The primary reason for controlling weeds during crop production is to eliminate crop yield losses due to competition between the crop and weeds. However, the majority of Iowa farmers strive to obtain higher levels of weed control than necessary to protect crop yields from weed competition. In most instances, the rationale for this contradiction is the concern over the impact of weed seed production on future weed populations. Most weed species are prolific seed producers, and seed dormancy enables weed seeds to survive for long periods of time. Thus, it is true that weeds allowed to go to seed in a field can impact weed populations for the next seven years - if not longer. Less clear, however, is whether the potential increase in weed population poses a real threat to the effectiveness of current weed management strategies.

Weed Seed Production, Dormancy and Longevity

A common characteristic of many weed species is the ability to produce tremendous quantities of seeds. A single giant foxtail plant has been reported to produce up to 10,000 seeds, whereas a pigweed plant may produce more than 100,000 seeds. This high level of productivity may result in extremely high numbers of weed seeds in the soil weed-seed reservoir. In one study, more than 200 million foxtail seeds per acre were found in the top inch of soil of an agricultural field. If all of these seeds would germinate in a single year, the resulting population would be nearly 5000 foxtail plants per square foot.

A second characteristic of weedy plants is the presence of seed dormancy. Seed dormancy is a condition in which seeds fail to germinate even when appropriate moisture, air and temperature conditions exist. Weed control would be greatly simplified if all the seeds germinated at one time, allowing weeds to be eradicated from a field by achieving 100% control during a single year. Most weed seeds, however, undergo periods of dormancy that insure they will continue to germinate over a period of many years.

The combination of prolific seed production and seed dormancy results in the persistent nature of weeds. As a result of these characteristics, we can only manage or control weeds, rather than eradicate them. Figure 1 shows the decline of viable velvetleaf seed in the soil when the addition of new seed was prevented. After 4 years of 100% velvetleaf control, the seed reservoir was reduced by approximately 90% in continuous corn and 80% in a corn-soybean rotation. However, more than 5 million seeds/A remained in the seed reservoir in both systems.
Once a weed has become established in a field, the longevity of seed insures that it will be a potential problem for the foreseeable future.

A Colorado study showed similar declines in the weed seed reservoir following standard management programs (Figure 2). The use of atrazine in combination with cultivation resulted in a continuous decline in the weed seed reservoir. However, when atrazine was dropped from the management system in 1978, the size of the seed reservoir increased due to greater numbers of weed escapes. These two studies illustrate the dynamic nature of the soil weed seed reservoir. The size of the weed seed bank can be reduced relatively quickly by maintaining high levels of weed control; however, due to the prolific seed production of most weed species, the seed reservoir is quickly replenished when weeds are allowed to go to seed.

**Impact of Weed Seed Reservoir on Weed Management**

The potential weed population in individual fields is determined by the size of the soil seed reservoir. The goal of many weed management programs is to obtain 100% control in order to minimize the size of the seed reservoir. It is assumed that by reducing the size of the seed reservoir, the effectiveness of weed management programs will be enhanced. This approach is based on attitudes developed at a time when the options available for weed management were not nearly as effective as those we have available today. Is this strategy necessary with today's technology, or could we save money by learning to accept a few weeds in the field?

It has been demonstrated that herbicide effectiveness can be reduced by overloading the system with high weed populations. This effect is illustrated in Figure 3, where the control of velvetleaf was reduced as the number of seeds per pound of soil was increased. At very high seed populations, emerging weed seedlings compete for the herbicide, therefore diluting the chemical to non-toxic concentrations. Although this data supports the goal of perfect weed control, it should be noted that the seed populations used in the study were quite high. A few velvetleaf escapes in a field would not increase the seed reservoir to the levels used in this experiment.

A project underway at I.S.U. is investigating the impact of low velvetleaf populations on future infestations and management strategies. In 1990, velvetleaf was established in soybeans at populations of 0, 5 and 10 plants per 100 ft of row. The impact of the seed from these plants on future velvetleaf populations will be followed for several years. As would be expected, 1991 velvetleaf populations were significantly higher in treatments where velvetleaf were present in 1990 compared to the weed-free treatment. In areas with no velvetleaf in 1990, 25 velvetleaf per 100 sq.ft. were found in 1991, compared to over 1200 plants per 100 sq.ft. in the 10 per 100 row-ft treatment. Although this dramatic increase in velvetleaf populations resulted in reduced velvetleaf control, the velvetleaf populations that escaped control were not at levels sufficient to threaten corn yields.
A study conducted in Pennsylvania investigated the impact of prior weed control on herbicide activity. In the first year of the study, three levels of weed control were established (0, 75, and 100%). The experiment was conducted at two locations; the Landisville location had a history of poor weed control, whereas at Rock Springs the field had been relatively weed-free prior to the experiment. Although annual grass control was reduced at both locations following poor control the previous year, acceptable giant foxtail control was maintained at Rock Springs regardless of previous treatment (Figure 4). At Landisville, the addition of weed seed to the existing large seed reservoir overcame the ability of the herbicide to maintain acceptable control. These studies demonstrate the potential impact of one year’s weed seed introduction on weed management programs, but also illustrate that the long-term history of a field is important. One year of poor weed control in a relatively clean field should not create an unmanageable weed situation.

Conclusions

Prolific seed production and seed dormancy are common characteristics of most weed species, and insure the long-term survival of weeds in agronomic fields. Due to the importance of the weed seed reservoir in determining weed populations and the effectiveness of weed management programs, the potential impacts of escaped weeds on the size of the weed seed reservoir must be considered. However, data does not support the common belief that 100% control is required in order to maintain weeds at a manageable level. It is difficult, if not impossible, to state what weed population is acceptable to leave in a field, but there needs to be a change in the zero-threshold concept for weed management held by many Iowa growers. Although growers’ do not need to lower their standards for weed control, they need to learn to accept low weed populations that occasionally escape primary management strategies.

Literature Cited


Figure 1. Longevity of velvetleaf seed reservoir.

![Graph showing the longevity of velvetleaf seed reservoir with data from Lueshen and Anderson (1980).](image)


Figure 2. Longevity of weed seed reservoir following standard management practices.

![Graph showing the longevity of weed seed reservoir with data from Schweizer and Zimdahl (1984).](image)

Schweizer and Zimdahl. 1984. C.S.U.
Figure 3. Effect of velvetleaf seed population on atrazine effectiveness.


Figure 4. Annual grass control with 1.8 qt/A Bicep as affected by prior year's weed control.