TILLAGE EFFECTS ON WEED MANAGEMENT

Since the beginning of agriculture, tillage in some fashion has been used to prepare a seedbed and manage weeds that use nutrients and water. Tillage can be used in the spring, in-season (rotary hoe, cultivation), and after harvest as a single tactic weed management tool or in combination with other control tactics such as herbicides, cover crops, and flame. The weeds in any given field help determine which tillage system, if any, should be used. Therefore, the weed species in a conventional tillage system can be very different than those in a no-till system.[1] The biology and growth habits of annual, biennial, and perennial weeds can greatly affect the type of tillage and tillage equipment necessary for managing weeds. Weeds are propagated by seeds, rhizomes, runners, and tubers; therefore, different control tactics are required for successful management.

Figure 1. Moldboard plow at Bayer Learning Center, Gothenburg, NE. Where appropriate, moldboard plowing can bury weed seed below germination levels.

Tillage prior to planting

Controlling weeds with tillage prior to planting is a major method to reduce weed density and is often referred to as primary tillage. However, weed control can vary greatly depending on the tillage implement (Table 1). Annual weed control can be greatly enhanced if primary tillage is used in combination with delayed planting, which allows the annual species to germinate prior to the tillage operation.[2] When considering using tillage as a primary weed control method consider the tradeoffs between the yield of a later planted crop against the need for tillage as a weed control tactic. If tillage is delayed until weeds become larger, the effectiveness of tillage can be reduced. Summer annual weeds that are not killed by tillage can be more difficult to control with herbicides later in the season.[3] Additionally, weeds that are injured by tillage and not killed can be harder to kill with herbicides because of their injured vascular tissue limiting the spread of the herbicide through the weed. Some examples of primary tillage implements are the moldboard plow and chisel plow, with the moldboard plow being more effective in burying weeds and weed seeds (Figure 1).

*Table 1. Weed Control Rating for Various Tillage Implements**

Implement	Seedlings	Established Annuals or Biennials	Simple Perennials	Creeping Perennials	Burying Annual Weed Seed
Moldboard Plow	Good	Good	Good	Fair	Good
Chisel Plow	Good	Fair	Fair	Poor	Fair
Disk Harrow	Good	Good	Good	Poor	Poor
Field Cultivator	Good	Poor	Poor	Poor	Poor

*Adapted from A practical guide for integrated weed management in Mid-Atlantic grain crops.[3]

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Secondary tillage is not as disruptive as primary tillage and is mainly used to prepare the seedbed. Secondary tillage controls small seedlings and germinating annual weeds by desiccation; therefore, it is best used when soil conditions are dry and temperatures are high.

The stale seedbed system employs an early tillage operation to stimulate weed seed germination (usually 30 days prior to planting). This is followed by a secondary, usually light, tillage operation to destroy the emerging seedlings prior to planting. The use of the stale seedbed system can help deplete weed seed banks, but control of the weeds that germinate should be as complete as possible to prevent replenishing the bank.[3]

*Table 2. Percent comparison of Amaranthus species seed emergence from various depths by tillage method in 2014**

	0 to 1.9 inches (0 to 5 cm)	1.9 to 5.9 inches (5 to 15 cm)	5.9 to 9.8 inches (15 to 25 cm)
Tillage Type	Percent of Total Seed Emerged		
No-till	71 to 81	17 to 25	0 to 9
Minimum Tillage	77 to 100	0 to 20	0 to 8
Conventional Tillage	71 to 77	22 to 29	0 to 5
Deep Tillage	20 to 25	63 to 80	0 to 13

*Dr. Kevin Bradley, University of Missouri. Influence of Tillage Methods on Management of *Amaranthus* Species in Soybean.[4] Data from one site each in Arkansas, Illinois, Indiana, Ohio, Tennessee, and Wisconsin and two sites in Missouri. Data used with the permission of Dr. Bradley.

In addition to reducing growing weeds, primary and secondary tillage can change the distribution of weed seed in the soil profile, which can influence germination and seedling establishment. In some cases, seed can get buried by tillage to a depth that retards germination (moldboard plow) and in others, tillage brings seed to the surface, providing an environment suitable for germination.[3] In a multi-state university study, the percent of germinating *Amaranthus* species seed from a depth of 5.9 to 9.8 inches (15 to 25 cm) was dramatically reduced compared to depths of 0 to 5.9 inches (0 to 15 cm) (Table 2).[4] The optimum emergence depth for different weeds can vary (Table 3).[3] Should a field, particularly a no-till field, develop high populations of herbicide resistant weeds that become unmanageable with chemistry, cover crops, or other methods, a one-time deep moldboard plowing might be a consideration to help return the field to a manageable weed level (Tables 3).

*Table 3. Average optimum emergence depth for six common weed species**

Weed Species	Emergence Depth (inches)
Broadleaf signalgrass	0 to 3/8
Common ragweed	0 to 1 9/16
Horseweed (marestail)	0 to 3/16
Palmer amaranth	0 to 1/2
Pitted morningglory	1 9/16
Slender amaranth	3/16 to 13/16

*Adapted from A practical guide for integrated weed management in Mid-Atlantic grain crops.[3]

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Generally, perennial weeds and small-seeded weeds (i.e., lambsquarter) are more common in no-till systems as the roots of the perennials are undisturbed and small-seeded weed seeds are not buried below the germination depth. On the other hand, some large-seeded weeds such as pitted morningglory may be unable to become established when seeds are left on the soil surface.[3]

Tillage after planting

There are two tillage types used for managing weeds after planting: blind cultivation and inter-row cultivation. Blind cultivation is done without regard to the crop rows and is usually used to dislodge small weeds; the most common implement used for blind cultivation is a rotary hoe (Figure 2). Plant size dictates the time limit on the use of blind cultivation. While corn and soybean are good candidates for blind cultivation, small-seeded crops are not as they can become easily dislodged. Timing is critical for blind cultivation to be successful; the "white thread" stage (seed has germinated but not emerged) of weed seed germination is associated with the most consistent control.[3]

Inter-row cultivation has become more precise and can be done with more speed with the advent of guidance support systems. While they were originally designed for low residue systems, equipment modifications now allow for use in higher residue systems. Usually there is more time to use inter-row cultivation with row crops as compared to using blind cultivation.

In summary, tillage can be used as a single tactic to manage weeds; however, it is important to know the weed species present in a field along with their growth habits for best tillage management. Primary, secondary, and blind tillage use different implements to kill weeds, dislodge weeds from the soil, or bury weed seeds. Consideration should be given to the use of tillage in conjunction with other cultural and chemical tactics to provide a more consistent and sustainable weed management program.

Figure 2. A rotary hoe can dislodge small weeds in a growing crop.

TILLAGE EFFECTS ON WEED MANAGEMENT

Sources

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Legal Statements