

### 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.<sup>1</sup> 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.<sup>2</sup> 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.<sup>3</sup> 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.<sup>3</sup>

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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.<sup>3</sup>

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.<sup>3</sup> 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).<sup>4</sup> The optimum emergence depth for different weeds can vary (Table 3).<sup>3</sup> 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 2. Percent comparison of *Amaranthus* species seed emergence from various depths by tillage method in 2014\***

|                      | 0 to 1.9 inches<br>(0 to 5 cm)       | 1.9 to 5.9 inches<br>(5 to 15 cm) | 5.9 to 9.8 inches<br>(15 to 25 cm) |
|----------------------|--------------------------------------|-----------------------------------|------------------------------------|
| <b>Tillage Type</b>  | <b>Percent of Total Seed Emerged</b> |                                   |                                    |
| 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.<sup>4</sup> 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.

**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.<sup>3</sup>

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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.<sup>3</sup>

## 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.<sup>3</sup>

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.*

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## Sources

<sup>1</sup>Buhler, D. 1995. Influence of tillage systems on weed population dynamics and management in corn and soybean in the central USA. *Crop Science* 35(5):1247-1258.

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<sup>2</sup>Hager, A. 2013. Control weeds before planting. University of Illinois Extension. farmdoc.

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<sup>3</sup>Cahoon, C., Curran, W. and Sandy, D. 2019. A practical guide for integrated weed management in Mid-Atlantic grain crops. VanGessel, M. (ed.) Pennsylvania State University, University of Delaware, Virginia Tech, and West Virginia University.

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<sup>4</sup>Farmer, J.A., Bradley, K.W., Young, B.G., Steckel, L.E., Johnson, W.G., Norsworthy, J.K., Davis, V.M., and Loux, M.M. 2017. Influence of tillage method on management of *Amaranthus* species in soybean. *Weed Technology*, 31, 10-20. <https://doi.org/10.1614/WT-D-16-00061.1>

Additional source:

Mohler, C.L., Teasdale, J.R., and DiTommaso, A. 2021. Chapter 4. Mechanical and other physical weed management. *Manage Weeds on Your Farm. Sustainable Agriculture Research and Education (SARE)*. National Institute of Food and Agriculture (NIFA) and United States Department of Agriculture (USDA).

## Legal Statements

**ALWAYS READ AND FOLLOW PESTICIDE LABEL DIRECTIONS. Performance may vary**, from location to location and from year to year, as local growing, soil and environmental conditions may vary. Growers should evaluate data from multiple locations and years whenever possible and should consider the impacts of these conditions on their growing environment.

The recommendations in this material are based upon trial observations and feedback received from a limited number of growers and growing environments. These recommendations should be considered as one reference point and should not be substituted for the professional opinion of agronomists, entomologists or other relevant experts evaluating specific conditions.

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