Organic farmers rely heavily on physical methods to manage weeds on their farms. We asked Maine organic farmers the question “how do you manage weeds?” From their responses, a ‘wordle’ was created, which shows how often key words were mentioned by displaying frequently-mentioned words in larger print (Figure 1). This wordle highlights that hand weeding and cultivation are among the most frequently cited weed control techniques used on Maine organic farms.

Hand Weeding

Hand weeding is a very effective means of weed control: one dutiful hand weeding pass can kill close to 100% of emerged weeds in a given field. This is true both when weeds are literally pulled by hand, and when precision (non-wheeled) hand tools are used. However, as weed pressure increases, so does the time needed to achieve this high level of control.1 This can translate to high labor costs when weed density is high (Box 1).

Cultivation

Cultivation describes tillage-based weed control carried out by tractor, horse, or person-powered machinery. One great advantage to cultivation is that a single cultivation pass typically takes the same amount of time (and money), regardless of how many weeds are present. However, the effectiveness of cultivation is variable, and can be low. Research shows that one cultivation pass will kill a fixed percentage of weeds, regardless of initial weed density. This percentage varies based on a number
of factors including type of machinery, experience of the operator, growth stage of weeds, and soil moisture, but is NOT dependent on starting weed density (Box 2).

Flaming

Flaming can kill large weeds as well as seedlings, but is more effective against broadleaf weeds. Because flaming does not require soil disturbance, it does not typically stimulate a ‘flush’ of new weed emergence, and is therefore a useful tool in stale seedbed preparation. Some disadvantages to flaming are that specialized equipment is required, and that the fossil fuel inputs are higher than those needed for other physical weed control methods.

Strategies

There are three major strategies for the farmer wishing to reduce her weed pressure through physical means: cultivate more, cultivate better, or manage the weed seedbank.

1) Cultivate More

Increasing the number of cultivation events each season is a simple and effective weed management strategy. The disadvantages are that cultivation can cause crop loss, takes time, requires fossil fuel for tractor operation, and can contribute to the spread of weed seeds and rhizomes.

2) Cultivate Better

Timing and tool choice are key to better cultivation. For maximal weed mortality, cultivate in dry conditions, when weeds are in the ‘white thread’ growth stage (Box 3). Before they develop true leaves and fibrous root systems, weeds are very vulnerable to both dessication and burial, and therefore easily killed by cultivation.

Tool choice also affects weed management success. Using the right cultivation equipment for your crop and soil, flaming when appropriate (especially to combat broadleaf weeds), and adjusting equipment and tractor speed appropriately can all contribute to highly effective organic weed management (Box 4).

Finally, understanding the biology of especially

Box 2: How does weed density affect cultivation?

Under the same conditions, a single cultivation pass will killed a fixed percentage of the weeds present, regardless of starting weed density. The diagram below illustrates this principle for a high 78% mortality rate per cultivation (which could be achieved under ideal cultivating conditions). The blue arrows represent cultivation events.

While it can be tempting to emphasize the positive - i.e. “I killed 78% of my weeds with one pass!” don’t forget that, if starting weed density was high, the remaining weeds (in this case, 22%) may still constitute a serious weed problem.
Box 3: Get ‘em while they’re white threads

The graph at right shows how cultivation becomes less effective as weeds grow in size.

Weeds are most vulnerable when they are in the ‘white thread’ growth stage, pictured below on the right side of the penny. Once true leaves start to form, as pictured on the penny’s left, the root system has already developed enough to hold onto soil when it is unearthed, making it much more resilient against disturbance, and harder to kill.

Box 4: Weed control machines

Farmers throughout the ages have invented and adapted weed control machines to suit their needs. Some examples of New England ingenuity are highlighted in the film Vegetable Farmers and their Weed Control Machines\(^2\) put out by UVM Cooperative Extension. In recent years, researchers and farmers in Europe have developed numerous novel weed control machines, including the examples highlighted here.

This robotic flame-weeder is mounted with a camera that distinguishes between weeds and crop plants, allowing it to automatically toast inter-row weeds.
problematic weeds (Figure 2) can help you plan crop rotations so that tillage or cultivation coincides with emergence, or preempts seed rain, of weeds you especially wish to control.

3) Reduce Your Weed Pressure

Other weed management strategies aimed at depleting the weed seedbank can simplify weed management long-term by reducing the starting weed density (Box 2), and therefore the time and effort needed to manage weeds in subsequent growing seasons. Check out to the Seedbank Management Bulletin in this series to learn more.

**Figure 2:** Graphs of weed seedling emergence on Maine farms over one growing season.

**Emergence of Common Weeds**

<table>
<thead>
<tr>
<th>Chickweed</th>
<th>Galinsoga</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lambsquarters</td>
<td>Low Cudweed</td>
</tr>
<tr>
<td>Purslane Speedwell</td>
<td>Quackgrass</td>
</tr>
<tr>
<td>Redroot Pigweed</td>
<td>Shepherd’s Purse</td>
</tr>
<tr>
<td>Spiny Sow Thistle</td>
<td>Wild Mustard</td>
</tr>
</tbody>
</table>

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**Literature Cited:**

2. Vegetable Farmers and their Weed Control Machines 2005 (video recording), Burlington, VT, Grubiger, V. & Else, M.J.