Delaying planting provides the opportunity to kill one or two "crops" of weeds prior to planting and allows the soil to warm up, resulting in rapid crop growth. Rapid crop growth is important in reaching a size differential between a larger crop plant and the weed. This size differential is required for success with many harrow, rotary hoe, and cultivation operations.

Properly timed mowing or cutting will suppress weeds but with few exceptions will not kill them. Cutting cedar trees (or other plants without basal buds) below the lowest branch will kill them. Mowing tends to be more effective on broadleaf weeds than grasses since most grasses rapidly regrow from the crown. Mowing must be carefully timed to maximize damage to the weed and minimize damage to the crop.

Physical barriers include placing black plastic sheeting (mulch) either on the soil surface or beneath a surface covering of gravel or stone. The crop or plant to be grown is planted through a hole cut in the plastic. Black plastic is important because it excludes sunlight from reaching weed seeds or small plants. Plastic mulch is most common with high value horticultural crops.

Propane-Fueled Flame Weeding

Flame weeding is an acceptable weed control option in organic production and has received renewed interest for conventional cropping systems. It can be used as part of an integrated pest management program not only for weeds but also for insect control in agronomic crops. Flame weeding controls weeds by heating plant tissue rather than burning it. Propane burners can generate combustion temperatures of up to 2000°F, which rapidly raises the temperature of the exposed plant tissues. The resulting thermal shock to the plant tissue boils water molecules inside the cells and breaks up proteins, especially in the cell wall. The expanding water generates a pressure that ultimately ruptures the cell wall, dehydrating the plant through cell leakage. Eventually plants die or their competitive ability is drastically reduced.

Pros and Cons of Flame Weeding

Flaming provides multiple advantages, such as:

- No chemical residue is left in plants, soil, air, or water.
- No drift hazard or herbicide carryover to the next season.
- Herbicide-tolerant or -resistant weeds are controlled.
- Reduced cost compared to hand weeding.
- Reduced need for repeated cultivation and the risk of new weed flushes or increased soil erosion.
- Reduced need for hand weeding in organic systems.

The disadvantages of flame weeding when compared to conventional herbicides include:

- Higher equipment cost than with traditional herbicide applicators.
- Precise timing of flaming operation is required for crop safety.
- Low application speed due to smaller coverage. (Most flamers treat four to eight rows, unless custom built for 16 or more rows.)
- Lack of residual weed control.

A flame weeder may have almost the same weed control capacity as a mechanical cultivator, but it is usually slower than those used for chemical weed control.

From a resource and environment point of view, the high energy requirement and the release of carbon emissions could be seen as a disadvantage; however, propane combustion is relatively clean compared to other fossil fuels, such as diesel.

Weed Response to Flame Weeding

Based on our recent research to determine how various weed species respond to broadcast flaming, propane doses of 10 to 12 gallons per acre were highly effective in controlling many broadleaf weeds at early growth stages (up to 10 inches tall), providing over 90% control of velvetleaf, ivyleaf morningglory, redroot pigweed, common waterhemp, lambsquarters, field bindweed, kochia, and Venice mallow. The same dose of propane also provided 80% control of several grass species, including barnyardgrass, green foxtail, and yellow foxtail. The weeds listed can be controlled prior to crop planting, as well as before and after crop emergence.

Control of perennials with flame weeding can be challenging as the flame's heat can't penetrate deep into the soil to destroy root structures. To provide control of perennial weeds, flaming will need to be repeated several times throughout the season.

Crop Tolerance to Flaming

We have determined the tolerance level of major crops to propane flaming. Depending on the tolerable crop injury level, a propane dose could be selected to either control the weed, or reduce its competitive ability against the crop. Crop susceptibility to propane flaming varies with species and growth stages.

Grass crops such as field corn, popcorn, sweet corn, and sorghum are most tolerant and can be safely flamed from their VE (emergence) to V10 (10-leaf) growth stages, with a maximum of two postemergence flaming operations per season.

Soybean is tolerant to flaming only at the VE–VC stages (emergence to unfolded cotyledon) and after the V4 (4 trifoliate leaves) growth stages. Sunflower is tolerant to flaming only at the VE–VC stage (emergence to cotyledon) and after the V8 (8-leaf) growth stage. Flaming in wheat is recommended only before crop emergence.

Cost of Flame Weeding

Cost of a single flaming operation broadcast below crop canopy could be $10-$12 per acre, excluding equipment and labor costs. (This estimate is based on a propane cost of $1/gallon applied at a rate of 10-12 gallons per acre.) A banded flaming application (over the crop row) can cost $5-$8 per acre due to lower propane use rates (4-6 gallons per acre).

Resources

For more information on flame weeding:

- Visit *http://propanecouncil.org* and search for the publication, *Propane-Fueled Flame Weeding in Corn, Soybean and Sunflower*, by Stevan Knezevic et al. The 30-page manual is free.
- Contact Extension Weeds Specialist Steven Knezevic at 402-472-6498 or sknezevic2@unl.edu.

Summary

Few nonchemical methods of weed control are so effective that any one can stand alone in providing acceptable weed control. An integrated weed management (IWM) program (see previous section) incorporating multiple approaches is important for success with nonchemical weed control.