Can We Use Steam To Control Western Washington Weeds?

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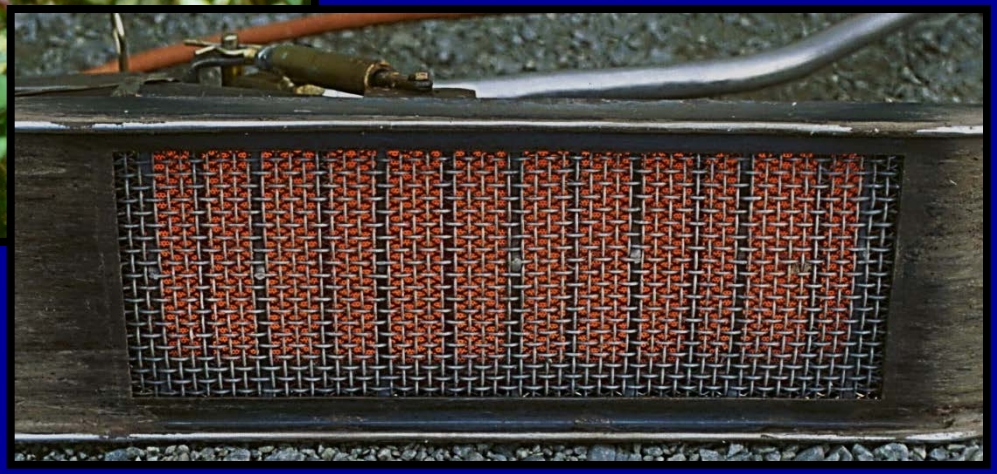
Can Weeds Be Killed By Heat?

- Sure!
- The concept is that newly-emerged weeds are very susceptible to heat, and that they lack the root reserves of energy to regrow after defoliation
  - If weeds are too old (maybe 3 or 4 leaves), they will grow back after flaming
- Most often, control is achieved by a quick exposure of emerged weed seedlings either to an open flame or to propane burners that heat a porcelain plate or a steel grid



Stale Seedbed:

Allow weed seeds to germinate, then kill them with herbicide, flame, or *shallow* tillage prior to planting

What About Weed Seeds Or Roots?

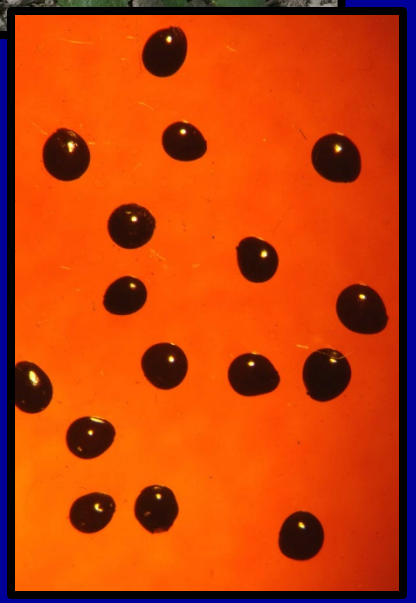
- This is more of a problem!
- Soil is a very good insulator, and it is difficult to raise the temperature of soil enough to kill buried, non-germinated (but still viable) weed seeds, or to damage well-established roots/rhizomes that are well below the soil surface
- Consequently, flaming is most effective as a postemergence weed control tool

Weed Seed Susceptibility To Heat

- Small-seeded broadleaf weeds and grasses are most susceptible to heat, while thick-walled seeds are remarkably tolerant

Weed Seed Susceptibility To Heat

- Seeds are more tolerant to heat when buried in dry soil than when in moist soil or compost
  - For example, 100% of redroot pigweed seed survived 7 days at 70° C in dry soil, contrasted with 20% or lower viability after treatment for 1 day at 60° C in moist soil (Egley, 1990)
  - 100% of redroot pigweed seed in compost was killed by 1 day at 60° C, while 30 days at 60° C in dry conditions only reduced seed viability to about 40% (Weise et al., 1998)



What About Steam?

- Steam is better able to force heat downward into soil than open flaming, and is much less likely to cause smoldering or unintended fires
- Heat causes an emerged plant's cells to burst and also melts away the outer waxy coating of leaves (the cuticle), leaving even otherwise intact cells more sensitive to desiccation
- Heating seeds causes denaturing of enzymes and other proteins inside, possibly resulting in damage or death of the embryo
- Variations of this approach use hot water, steam, hot foam, and super heated steam

Pluses And Minuses Of Steam

- Benefits
  - No fire hazard from the application itself
  - Herbicides are sometimes not appropriate (or available) for some sites
  - Safe for people and animals after application
- Limitations:
  - Slow: an estimated 5.6 acres per day for some systems
  - Uses a lot of water and a lot of fuel
  - Usually must be done during daytime
  - Incomplete control of established perennials

Does Steam “Fit”?

- Steam weed control may be useful in areas where herbicides are not allowed, or on those areas where use of other mechanical techniques are not appropriate due to surface topography, presence of rocks or woody vegetation, or on ecologically sensitive sites
- At its most essential, steam is nothing more than hot water, so there are few environmental concerns
  - Use of surfactants change this situation slightly
- Steam can be used to kill plants growing in cracks, around posts, at the base of guardrails, and around the base of well-established trees

First (?) Steam System For Weeds

- In the early 2000s, the New Zealand Waipuna system became popular in the US
- Mixes hot water (98° C) with surfactant to create a foam that maintains heat a little longer than straight steam

One and two-wand systems, are available from Waipuna

Before

After

Costs Have Been Estimated For New Zealand Waipuna System

- Waipuna boiler system ~$28,000
- Foam additive: $900 per 55 gallon barrel
- Treatment cost/acre: $72.42 (Waipuna system with foam; not including initial investment)
  - Maybe 25% more than herbicide treatment (time and product)

Steam-Flo System

Does Steam-Flo Control Weeds?

- In Gary's experience at WSU Puyallup, yes!
- Testing the system for control of soil pathogens in conifers, he found it provided excellent control of many annual weed species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Questions To Ask About Steam

- What weed species do I have?
  - Are there established perennials or hard-seeded annual weeds present?
- What plant species am I producing?
  - Are there herbicides available for use that might better control the weeds I have?
- Do I have the ability to move the steam-generating equipment onto the site to be treated and use it effectively?
- Can I use this equipment for other purposes besides weed control?


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