

Hot Water as a Substitute Weed Killer

Is chemical herbicide really the
best option?

Introduction

- ▶ Weeds are a problem commercially and for individuals
- ▶ Chemical herbicides are commonly used, but may harm wildlife, other plants and even humans
- ▶ This study evaluated hot water as a substitute weed killer
- ▶ Prior research studies have evaluated the use of heat for killing weeds:
 - ▶ T. Astatkie et al. examined the effectiveness of hot water, infrared, and open flame thermal units as alternate approaches to weed control. In their study, the scientists found that hot water was not as effective as expected at killing weeds.
 - ▶ Martelloni et al. conducted an experiment in which flaming, glyphosate, hot foam, and nonanoic acid were compared to see which provided better weed control. Martelloni concluded that after 29 days of treatment, hot foam as well as glyphosate and flaming, were superior to nonanoic acid in reducing weed growth.
 - ▶ Werner Kurfess and Siegfried Kleisinger did an experiment to see if hot water could kill the weeds in an orchard. After twenty-four hours of the treatment of hot water, the weeds became wilted and brown wherever the hot water was applied.

Introduction, cont.

- ▶ Hot water works because it distorts and then kills the plant/weed cells by the transfer of heat energy
- ▶ Prior experimentation has focused on large-scale weed control operations.
- ▶ Hot water for weed control may be most practical for the home gardener, though care must be taken to avoid accidental exposure of hot water to desired plants.
- ▶ In this study, hot water and standard weed killer were applied to *Helianthus annuus* (Sunflower).



Is hot water just as effective in killing weeds as standard weed killer?

Let's find out...

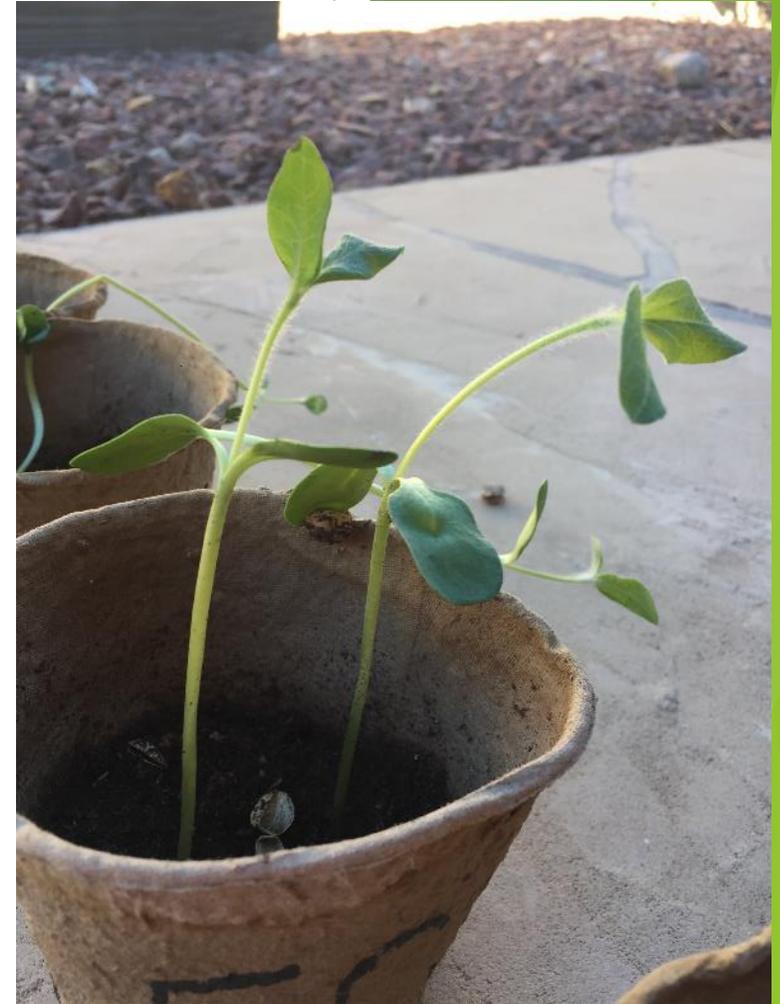
Procedure

- ▶ Ten planting cups were labeled for each treatment group as follows: 1A-10A; 1B-10B ; 1C-10C.
- ▶ Soil was placed in all cups for each treatment group, to the level of 5 cm from the cup's top. Three small holes 1cm deep were made in the soil; one sunflower seed was placed in each hole.
- ▶ Each cup was watered with 30 mL of water directly over planted seeds.
- ▶ Cups were watered daily with 30 mL of water for 10 days. As the sunflowers sprouted and grew, the amount of water applied to every cup was increased to 60 mL. This occurred on day 8 of the study.



Procedure, cont.

- ▶ After the sunflower plants had grown to a height of between 8-18 cm, the weed treatment methods were applied to the cups.
- ▶ 30 ml of water boiled to 100 C was applied to the base of each plant in cups 1A-10A.
- ▶ Two complete sprays of standard weed killer containing the active ingredient, glyphosate, was sprayed over cups 1B-10B.
- ▶ Cups 1C-10C served as the control for this experiment and received no treatment other than watering. Data was recorded including how fast the plants wilted and/or died in each group. Death was if the plant wilted or collapsed. Time to death of plant was recorded in minutes.



Results

- ▶ Subjective observations of plant status were taken at intervals following the treatment applications.
- ▶ The plants were rated according to the following scale reflecting 'plant health,' and assigned a number score:

5: green in color, stiff in stem turgor, smooth in leaf texture

4: green in color, slightly flexible in stem turgor, smooth in leaf texture

3: brownish green in color, weak in stem turgor, withered in leaf texture

2: more brown than green in color, soft and weak in stem turgor, brittle in leaf texture

1: brown in color, withered in stem turgor, decayed and/or crunchy in leaf texture



Results, cont.

- ▶ **1 hour after hot water treatment...**
 - ▶ Cups 1A-10A were pale green in color, stiff in stem turgor and smooth in leaf texture (Score: 5).
 - ▶ Cups 1B-10B were pale green in color, stiff in stem turgor and smooth in leaf texture (Score: 5).
 - ▶ Cups 1C-10C were pale green in color, stiff in stem turgor and smooth in leaf texture (Score: 5).
- ▶ **25 hours after hot water treatment...**
 - ▶ Cups 1A-10A were pale green in color, stiff in stem turgor, and smooth in leaf texture (Score: 5).
 - ▶ Cups 1B-3B, 5B-7B and 9B-10B were brownish green in color, weak in stem turgor, and brittle in leaf texture (Score: 2.5). Cups 4B and 8B were pale green in color, stiff in stem turgor and smooth in leaf texture (Score: 5).
 - ▶ Cups 1C, 2C, 3C, 6C, 8C, and 9C were pale green in color, stiff in stem turgor, and smooth in leaf texture (Score: 5). Cups 4C, 5C, 7C and 10C had a withered leaf texture (Score: 4).

Results, cont.

- ▶ 40 hours after hot water treatment...
 - ▶ Cups 1A-10A were pale green in color, weak in stem turgor and smooth in leaf texture (Score: 4).
 - ▶ Cups 1B, 2B, 3B, 5B, 6B, 7B, 9B and 10B were brownish green in color, shriveled in stem turgor, and brittle in leaf texture (Score: 2). Cup 4B was brownish green in color, stiff in stem turgor, and brittle in leaf texture (Score: 3). Cup 8B pale green in color, shriveled in stem turgor, and brittle in leaf texture (Score: 3).
 - ▶ Cups 1C-3C were pale green in color, stiff in stem turgor, and tough in leaf texture (Score: 4.5). Cups 4C-7C were pale green in color, stiff in stem turgor, and withered in leaf texture (Score: 4.5). Cups 8C-10C pale green in color, stiff in stem turgor, and smooth in leaf texture (Score: 5).



Hot Water Application



Weed Killer Application

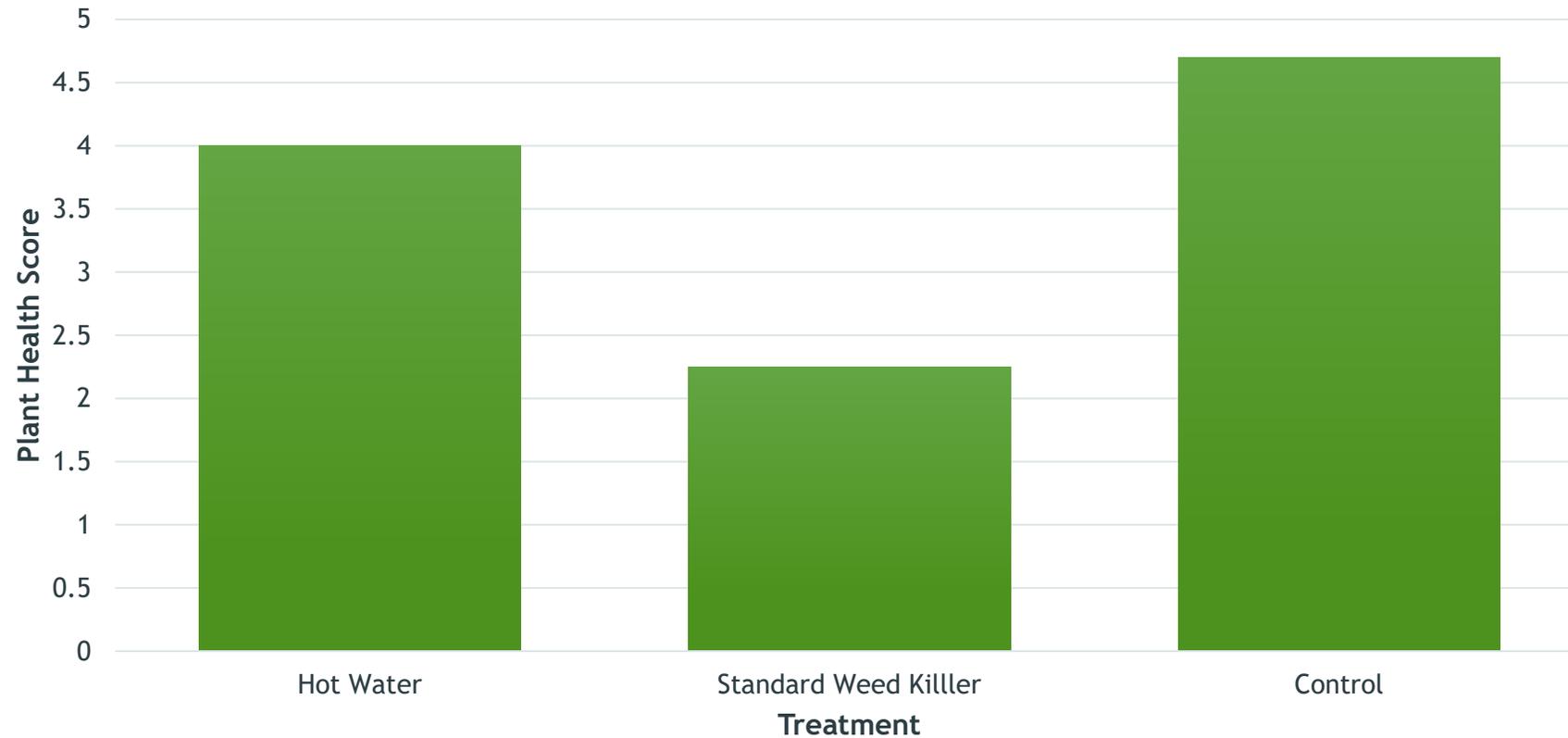


Control

40 hours after treatment

Results Graph

Plant Health Score After 40 Hours by Treatment



Plant Health Score Scale:

5: green in color, stiff in stem turgor, smooth in leaf texture

4: green in color, slightly flexible in stem turgor, smooth in leaf texture

3: brownish green in color, weak in stem turgor, withered in leaf texture

2: more brown than green in color, soft and weak in stem turgor, brittle in leaf texture

1: brown in color, withered in stem turgor, decayed and/or crunchy in leaf texture

Discussion

- ▶ The purpose of this experiment was to see if hot water could be used as an effective substitute for weed killer.
- ▶ **Major findings:**
 - ▶ Hot water application did kill the weeds (sunflowers in this experiment), though less effectively than did the standard weed killer.
 - ▶ The weeds killed by the herbicide were more shriveled than the ones killed by hot water.
 - ▶ The time to plant death was also longer for the group treated with hot water as compared to the group which received the herbicide.
 - ▶ The control group which received only tap water for irrigation and no herbicide or hot water, remained healthy as expected, demonstrating normal growth.
 - ▶ The data supports the idea that it was the herbicide that led to the death of plants in Group A and the hot water application that led to the death of plants in Group B.



Discussion, cont.

- ▶ **Several sources of possible error in this study that could have contributed to incorrect results:**
 - ▶ There may have been some error in the hot water and weed killer application, with slightly more weed killer or hot water applied to one plant than another.
 - ▶ The hot water should also have been reheated each time to the same degree after pouring over each plant, as the water may have cooled down very slightly from plant to plant.
 - ▶ The plants were watered all at the same time of day, though the time of watering varied from day to day.
 - ▶ There may also have been some variance in the manner in which each pot was moved or adjusted during the study. This movement, though slight, could have affected plant growth and susceptibility to the weed killing procedures.
 - ▶ There may have been some variance in the depth of planting of each of the seeds.

Discussion, cont.

- ▶ Several areas for future research related to this topic:
 - ▶ Evaluating different types of hot water application such as spraying the hot water instead of pouring it could provide better efficacy in weed killing.
 - ▶ Adjusting the area of the plant targeted with the weed killer or hot water might also give different results, such as applying over the leaves or stem instead of at the roots.
 - ▶ Applying more of each substance to see if that is more effective might also provide different results.



References:

- ▶ Astatkie T., et al. Effectiveness of Hot Water, Infrared and Open Flame Thermal Units for Controlling Weeds. 2007. *Biological Agriculture and Horticulture*. pp. 1-12
- ▶ De Cauwer et al. Efficacy and reduced fuel use for hot water weed control on pavements. 2015. *Weed Research* 55. pp. 195-205
- ▶ Kurfess W., Kleisinger K et al. Weeds in Hot Water. 1999. *Resource*. pp. 13-14
- ▶ Lingenfelter, Dwight et al. What are weeds and their impacts? 2007. *Introduction to Weeds and Herbicides* pp. 1-4
- ▶ Martelloni L., Frasconi C., et al. Flaming, Glyphosate, Hot Foam and Nonanoic Acid for Weed Control: A Comparison. 2020. *Agronomy*. pp. 1-14
- ▶ Rifae M. N., et al. Alternative Methods of Weed Control in Apple Orchards. 2000. *Pakistan Journal of Biological Sciences* 3. pp. 933-938
- ▶ University of California Agriculture and Natural Resources State Integrated Pest Management Program. “Weed Management in Landscapes.” 2019