

Garlic producer closes in on successful weeding strategies

Effectiveness and economic impact of weed control systems in organic garlic production

Organic gourmet hardneck garlic is an excellent high value crop that can be profitably grown on a few acres. Unfortunately, organic hardneck garlic is extremely labor intensive. Almost all work must be done by hand to preserve crop quality and extend storage life. The prospect of hand weeding an acre or two discourages many potential growers.

Weeding hardneck organic garlic is a time consuming but necessary job. Garlic is unable to compete with weeds. Even moderate weed coverage can severely reduce garlic yield and bulb size. Garlic plants emerge slowly in the spring and never form a canopy to discourage weed growth, due to their short upright leaves. Even in vigorously growing healthy garlic, weeds can quickly overwhelm a garlic field.

Garlic's nine to ten month growing season forces growers to combat multiple flushes of winter annuals as well as spring and summer annuals. Perennial weeds such as field bindweed, Canada thistle and quackgrass can also be a problem.

To help organic farmers choose suitable weed control, we evaluated the effectiveness of four different weed control methods: solarization, stale tillage, hand weeding and flame weeding, on two varieties of organic hardneck garlic: German Red and Georgian Crystal.

Pre-planting weed control included solarization or stale seedbed technique. Solarization used plastic placed over the crop bed to heat up the soil and kill weed seedlings and seeds. Stale seedbed technique used repeated shallow cultivation before planting to destroy emerging weeds.

Post-planting weed control compared hand weeding with flame weeding. We evaluated weeding time, weed coverage, garlic bulb weight (total yield), garlic bulb size, and the economic feasibility for all weed control methods.

These weeding methods were selected because they are common among organic producers. Studies report that solarization reduces weed coverage



Photos by Chris Bailey

Above: Susan discusses weed control research during an on-farm garlic field day; **Below:** Checking emerging plants in the weed research trial, April 2009.

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OFRR funding awarded: \$10,362 (1 year) **Project period:** 2008-2009. **Report submitted:** December 2009. *The complete project report (17 pages) includes detailed methods, additional data, discussion, and economic analysis and is available at ofrr.org*



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and increases yields in horticultural crops when compared to conventional tillage. When we conducted this experiment, I expected to see a decrease in weeds and no change or a slight increase in yield in the solarized plots when compared to stale tillage technique. I also expected flame weeding to be a faster method of weed control when compared to hand weeding. The actual results, in particular a 10% yield reduction caused by solarization, surprised me.

Project objectives were to determine which weed reduction system is the most economically effective by:

- 1) Determining total labor and material cost for each weed control system;
- 2) Determining effectiveness of each weed control system by recording percent weed species emergence and percent weed cover throughout the year;
- 3) Determining total garlic yield for each weeding system;
- 4) Determining garlic quality, as measured by bulb size, for each weeding system.

Experimental design was a split plot randomized block design. The two main treatments were pre-planting solarization and stale seedbed technique. The subplots were garlic variety (GR or GC) and weeding method (flame or hand). Each of the larger main plots contained four randomized subplots: GR flame weeded, GR hand weeded, GC flame weeded or GC hand weeded. There were four repetitions per main plot treatment for a subtotal of 16 plots (total 32 plots). This was a large experiment covering approximately 1/10 of an acre and containing 8,000 garlic plants.

Plots were approximately 48" by 252" (4 x 21 feet) with six garlic rows spaced eight inches apart. Each plot contained approximately 250 garlic plants.

Garlic was planted the week of October 20th, four inches deep and six inches apart within each row.

Plots were mulched with four to six inches of straw immediately after planting.

Garlic emerged in late February.

In stale seedbed technique the crop bed was cultivated on Sept 6th approximately 6 weeks before planting to encourage a flush of weed growth. Shallow tillage every 2 weeks (on Sept 20, Oct 4, and Oct 18) was used to destroy emerging weed seedlings.

In solarization, clear UV resistant plastic was anchored over the soil using concrete blocks and pallets on Sept 6th for 6 weeks.

Garlic in the plots was weeded either by hand or by flame weeder (Weed Dragon®, propane torch) weekly from May 12th to July 7th (a total of nine weeks).

Bulbs were harvested on August 12th and 13th and cured for 6 weeks before taking yield measurements.



Chris Bailey

Flaming some weeds in our experiment.

Project Results

❖ Solarization reduced weed coverage compared to stale seedbed technique

- Weed coverage averaged 3% with stale seedbed and 2.1% with solarization.

❖ Solarization decreased garlic bulb size and weight compared to stale seedbed technique

- Solarization significantly decreased garlic bulb size by 5.5% and garlic bulb weight by 10% compared to stale seedbed.
- Garlic bulbs in plots treated with solarization averaged 2.2 inches across and 76.9 grams. In contrast, garlic bulbs in plots treated with stale seedbed averaged 2.4 inches across and 84.8 grams. This is an economically significant difference.

- Average yield with solarization was 13,550 lbs/acre compared to 14,943 lbs/acre with stale seedbed. Stale seedbed increased yield by 1,393 lbs/acre.
- ❖ **There was no difference in the time spent weeding between flame and hand weeding**
 - Flame and hand weeding took an average 6.2 and 6.5 minutes per plot, respectively, during the weeding season. These two weeding methods were not significantly different over the entire weeding season.
 - Flame weeding took significantly less time than hand weeding (7.3 min/plot vs. 11.3 min/plot) over the first month.
 - At week 5 hand weeding became less time consuming than flame weeding.
- ❖ **Bulb size was different between the two hard-neck garlic varieties**
 - German Red was significantly larger than Georgian Crystal. Georgian Crystal bulbs averaged 2.24-2.26 inches across compared to German Red bulbs which averaged 2.31-2.40 inches across.
- ❖ **There was no difference in bulb size due to flame or hand weeding**
 - Weeding method did not significantly affect bulb size in either hardneck garlic variety.
- ❖ **Bulb weight was significantly heavier in hand weeded German Reds**
 - German Red was 11% heavier when hand weeded. Hand weeded German Red averaged 86.6 grams/bulb compared to flame weeded German Red at only 77.5 grams/bulb. This is an economically significant difference.
 - There was no difference in bulb weight between flame and hand weeded Georgian Crystal.
- ❖ **Weed coverage was greater in flame weeded plots**
 - Overall the weed coverage was three times greater in flame weeded plots than hand weeded plots (3.7% compared to 1.3% weed cover). This indicates that flame weeding was not killing as many weeds.

- Most of the weeds remaining in the flame weeded plots were noxious weeds that are flame resistant.

Average cost for weed control was determined for each 4' x 21' plot using total material, labor and machine costs. Average cost per plot for pre-planting weed treatment varied from a low of \$1.90 for stale seedbed to a high of \$10.69 for solarization (\$5.31 for a second year of solarization if plastic is reused). Flame weeding costs per plot were \$14.20 and hand weeding costs were \$9.73.

Economic feasibility for each of these weed control methods was determined using weed control costs per pound of garlic. Using these criteria, the most economical combination of weed control methods was stale seedbed followed by hand weeding. The least economically feasible was solarization followed by flame weeding. Stale seedbed followed by hand weeding cost only \$0.25 per pound of garlic produced. Due to lower yield and higher weed control cost, solarization followed by flame weeding was the most costly at \$0.61 per pound of garlic produced.

Conclusion

The most effective weeding combination as measured by cost, weed control and total yield was stale tillage followed by hand weeding. This weed control combination had the lowest cost with the highest total yield and largest bulb size for both garlic varieties.



Susan Fluegel

Patty holds some beautiful Georgian Crystal harvested from our weed control research.

