Organic Control of Canada Thistle in Mulched Orchards

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Summary

With funding from a USDA-SARE Farmer Rancher grant, we compared several methods of eliminating dense Canada thistle patches growing in bark mulch in our organic apple orchard. Any method of repeatedly killing the thistle shoots on three week intervals eliminated the weed within two growing seasons. Of the four methods we applied, cutting shoots with a gas powered string trimmer and cutting them with a diamond hoe were least costly; spraying an organic herbicide was expensive because of the cost of spray, and hand-pulling shoots was expensive because of the labor time required. Applying a layer of cardboard mulch underneath the bark mulch reduced subsequent weeding time and hastened the decline in thistle populations, but was not cost effective because the time required to apply the mulch outweighed the subsequent time savings.

Background and Objectives

Most apple farmers raise dwarf trees because they provide a quicker return on investment, produce better quality fruit, require less labor, suffer less disease and are easier to spray. However, dwarf trees have shallow root systems and compete poorly with weeds. Many organic apple growers with dwarf trees rely on wood chip or bark mulch (by-products from local sawmills) to suppress annual weeds around their trees, but over time aggressive perennial weeds such as Canada thistle can invade the mulched area. Canada thistle presumably competes for water and nutrients with apple trees. In addition, tall prickly thistle plants infuriate orchard workers attempting to work near the tree trunk and lower branches. Canada thistle has deep roots and once established it is very difficult to eliminate using organic methods. Digging out the thistle roots would be extremely time-consuming and destructive to the nearby apple trees and is not feasible. Previous research has shown that repeatedly killing thistle shoots by mowing or other means can deplete thistle's root reserves and gradually suppress or eliminate it. However, it is necessary to kill Canada thistle shoots every three weeks to eliminate an established patch. If the thistle shoots are killed at longer intervals, new shoots will grow and replenish the energy stored in the roots between each shoot killing. Figures 1 and 2 illustrate this.

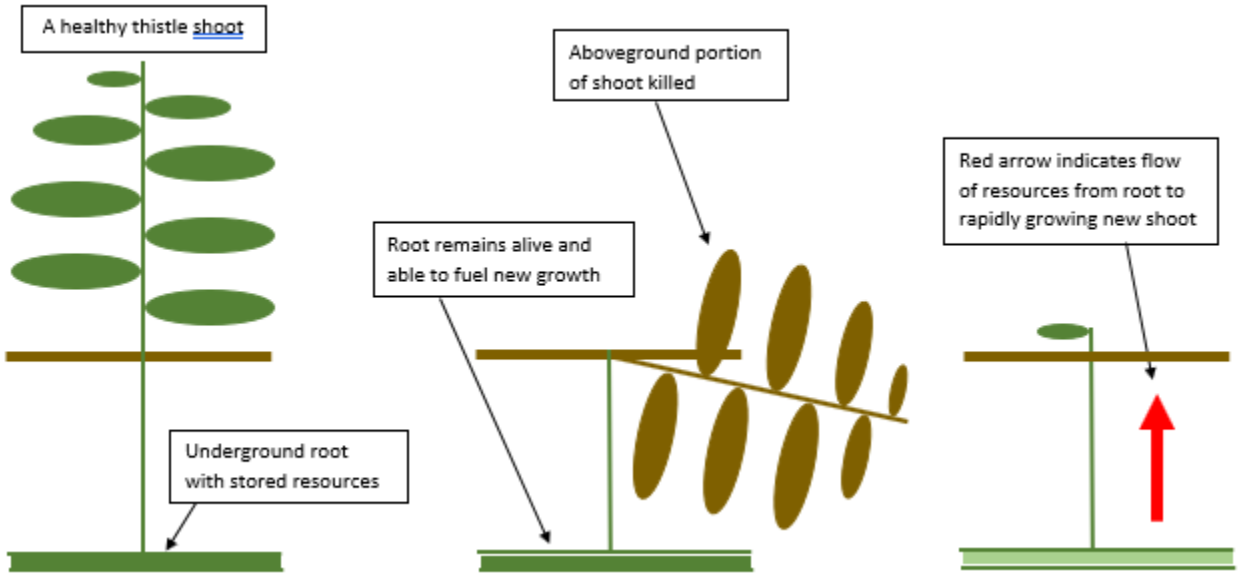

Figure 1. After shoots are killed, Canada thistle depletes root reserves to regrow.

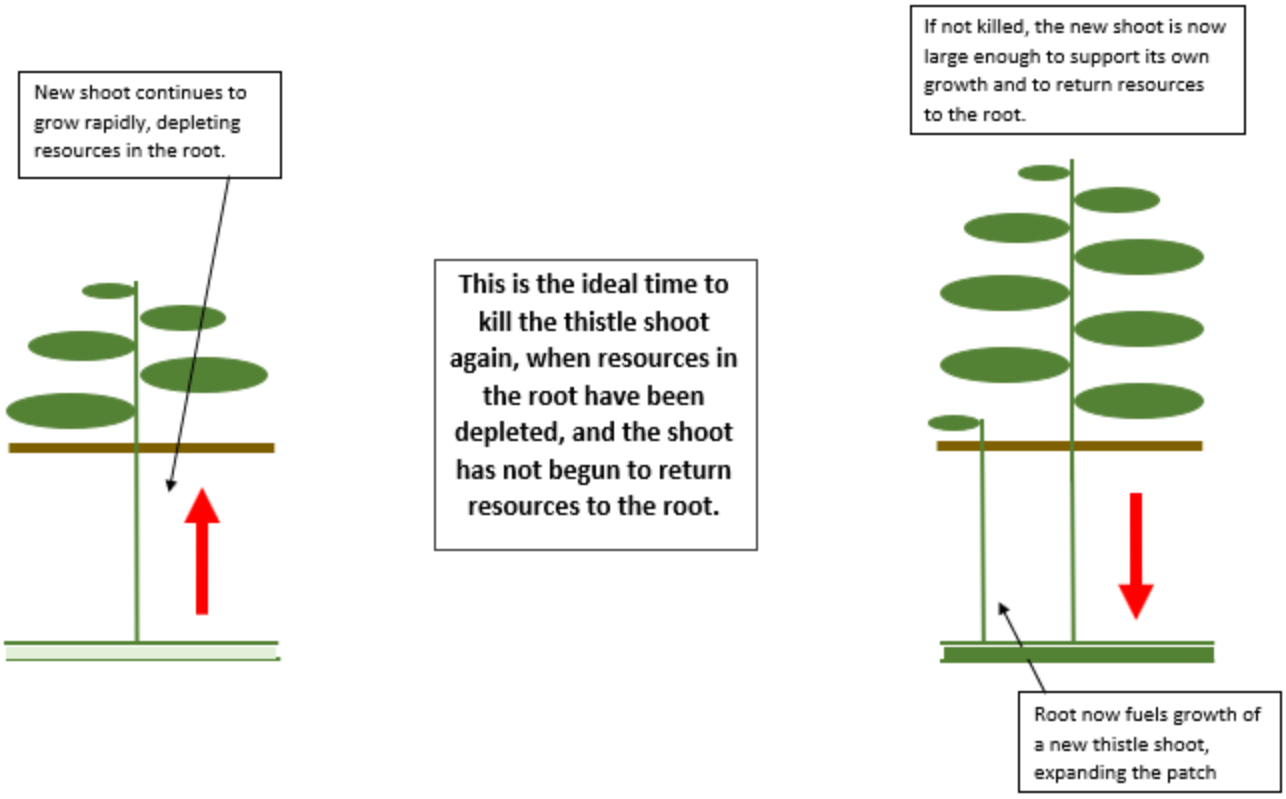

Figure 2. The ideal time to rekill the shoots is before the new shoot has begun to replenish underground energy reserves

Unfortunately, this repeated killing of shoots at three week intervals is time-consuming and difficult to accomplish on a commercial scale. Our goals were to measure the time requirements and effectiveness of four methods of killing Canada thistle shoots in our apple orchard: hand-pulling, spraying with an organic herbicide, mowing with a string trimmer, and cutting shoots off with a hoe. We applied each of these four methods repeatedly at three week intervals. We selected the four methods for these reasons:

(1) Hand-pulling – a basic, effective, but possibly time-consuming method.
(2) Hoeing – In our experience, a flat bladed diamond hoe (Dewit #31-10) works well in bark mulch because a user can easily slide the blade under the mulch without disturbing the mulch excessively.
(3) Spraying – We chose Avenger herbicide (active ingredient Limonene) because it has effectively killed Canada thistle shoots in small tests on our farm and because it works in cloudy and cool conditions, unlike some other organic herbicides. It is not toxic to the trunks of apple trees. Note that Avenger and other organically approved herbicides are contact herbicides without systemic activity.
(4) String trimming – A method of mowing the thistle shoots close to the ground which is feasible in uneven bark mulch and around tree trunks.

In addition, we evaluated each technique in plots mulched with bark only and in plots mulched with both bark and an underlying layer of cardboard. Cardboard mulch may reduce shoot density and make other treatments less time-consuming to apply. Cardboard will not eliminate thistles because some shoots always emerge at seams and edges. Used (recycled) cardboard is a readily available material which biodegrades within two growing seasons. We chose cardboard instead of plastic mulch to avoid reliance on synthetic, non-recyclable products.

Research Methods

This two year study was conducted in the 2019 and 2020 growing seasons.

Organic. Our entire farm is certified organic by MOSA (mosaorganic.org) and only organic methods were used in this research.

General Orchard Groundcover Management. Our dwarf apple trees are planted 6' apart within the row and approximately 10.5' between rows. Under each tree row, we attempt to maintain a 5.5' weed-free strip. This strip is mulched with 4" of hardwood bark after trees are planted, and we apply 1-2" of additional bark each subsequent year in late fall, winter, or early spring. Between rows, we maintain a grass/clover sod approximately 4' wide.

Figure 3. Bark mulch and adjacent sod

Between the sod and the mulch we maintain a narrow strip of bare soil (about 6" wide) by using a homemade three point hitch mounted cultivator (see figures below).

Figure 4. Cultivating bare strip between mulch and sod

Figure 5. Rear, close-up view of one side of cultivator

This experiment relates to Canada thistle control in the bark mulched strip. We have found that weekly close mowing of grass aisles and cultivation of the cultivated strip every 7-14 days when soil conditions permit is sufficient to largely control or eliminate thistle in those areas, but that thistle can proliferate in the mulched strips. Once it invades the mulched area, it spreads rapidly via underground runners.

In addition to Canada thistle, there are several other common weeds in our orchard. Bark mulch controls most annual weeds, presumably by blocking sunlight from reaching dormant weed seeds in the soil below. Crabgrass and other annuals do sometimes establish at the edge of the mulch where cultivation disturbs the soil/mulch border. Dandelions invade the mulch over time as windblown seeds germinate on top of the mulch. In addition to Canada thistle, other spreading perennial weeds such as quackgrass, horsenettle, and field bindweed can sometimes invade the mulch and once there, spread aggressively via underground runners. Fescue and white clover from the sod strips rarely invade the mulch.

Varieties and rootstocks. Our orchard consists of scab-resistant varieties grown on dwarf rootstocks. The thistle-infested blocks used in this study include these varieties: Initial, Sansa, Winecrisp, Pristine, Akane, Redfree, Williams Pride, and Prima. Rootstocks in these blocks are primarily G. 11, G. 16, and G.41, with small amounts of G. 202 and Bud. 9. With the exception of some replants, the blocks used in this study had been planted from 2012-2015.

Layout of Experimental Plots. We selected 14 blocks (each 5.5'x48') in our orchard where Canada thistle is abundant. We divided each block into eight plots (5.5'x6'): 5.5' is the width of the mulched strip under our apple trees and our trees are spaced 6' apart, so each plot was centered on a single tree. We randomly assigned the eight plots in each block to one of eight treatments (the eight treatments were four methods of killing thistle shoots, each performed with and without cardboard mulch).

Cardboard Mulch. We applied cardboard mulch in April, 2019: we first removed bark mulch from these plots, then laid recycled cardboard on the ground, overlapping cardboard pieces by 6-12" at edges, and finally reapplied bark mulch on top of cardboard. We recorded the time required to apply the cardboard.

Thistle killing methods. Every three weeks from May to September we performed weed killing treatments. (Treatment dates in 2019 were May 22, June 14, July 4-5, July 26, August 14, September 4, and September 25; treatment dates in 2020 were May 15, June 4, June 30, and July 23; no thistles were observed in experimental plots at the last two treatments, and treatments were halted at that time).

(1) Hand-pulling –We pulled out each weed with as much of its underlying vertical root as was easily removable – in some cases thistle shoots broke off near the surface and in other cases we removed up to 6 or 8 inches of below ground stem.

(2) Hoeing – We used a flat bladed diamond hoe (Dewit #31-10). These work well in bark mulch because a user can easily slide the blade under the mulch without disturbing the mulch excessively. When hoeing, we aimed to cut each shoot below the surface of the bark mulch, but above the cardboard mulch or soil.
(3) Spraying - We mixed 1 quart of Avenger with 3 quarts of water to make one gallon of spray solution and thoroughly doused weeds to the point of runoff.
(4) String trimming – We used a Honda HHT35 string trimmer to cut all weeds off as close to the mulch surface as possible.

Figure 6. Head of DeWit 31-10 diamond hoe

Figure 7. Honda HHT35 string trimmer

When we applied these treatments we applied them to all weeds in the experimental plots, not just Canada thistle. We felt that this was the most realistic way that practicing farmers would apply the treatments on their farms.

We recorded the time required for each treatment in each plot; setup/cleanup time required for each treatment (e.g., filling and rinsing sprayer tank, adding gas to string trimmer); and the amount of spray and gas used.

Thistle Density Data. Canada thistle patches can be dense (>10 shoots per square foot). To reduce time required for data collection, we only counted shoots in the northeast quarter of each plot. We counted live thistle shoots on April 23, 2019 before applying cardboard mulch, and again immediately before applying each round of thistle killing treatments. (We counted each thistle shoot emerging from the bark mulch as one shoot, although in some cases several shoots may have originated as branches of a single shoot which diverged below the surface of the mulch.)

Results

Thistle Shoot Density. As the graph below shows, thistle shoot density declined dramatically in all treatments over the course of the first year and remained low during the second year. This confirms that any method of repeatedly killing thistle shoots on a three week interval will greatly reduce populations. Over all treatments, the thistle shoot density declined from a high of 1.438 shoots per square foot on 6/12/2019 to 0.005 shoots per square foot on 9/25/2019. It is

difficult to overstate the extent of the decline – this was a 200 fold reduction in thistle density within one growing season! By the time of the last treatments in July, 2020, no thistle shoots were counted in the experimental plots. Another very evident trend was that cardboard mulching resulted in a much quicker reduction in thistle density. On 5/22/2019 and 6/12/2019, thistle densities in cardboard mulched plots was only 25-30% of the density in plots not mulched with cardboard. However, this difference declined thereafter and by the end of 2019 thistle density was near zero in all plots. In addition, the decline in thistle density in plots without cardboard mulch where weed trimming was used was slower than in plots without cardboard mulch where other treatments were used. This trend was particularly evident in density measurement data from 7/4/2019.

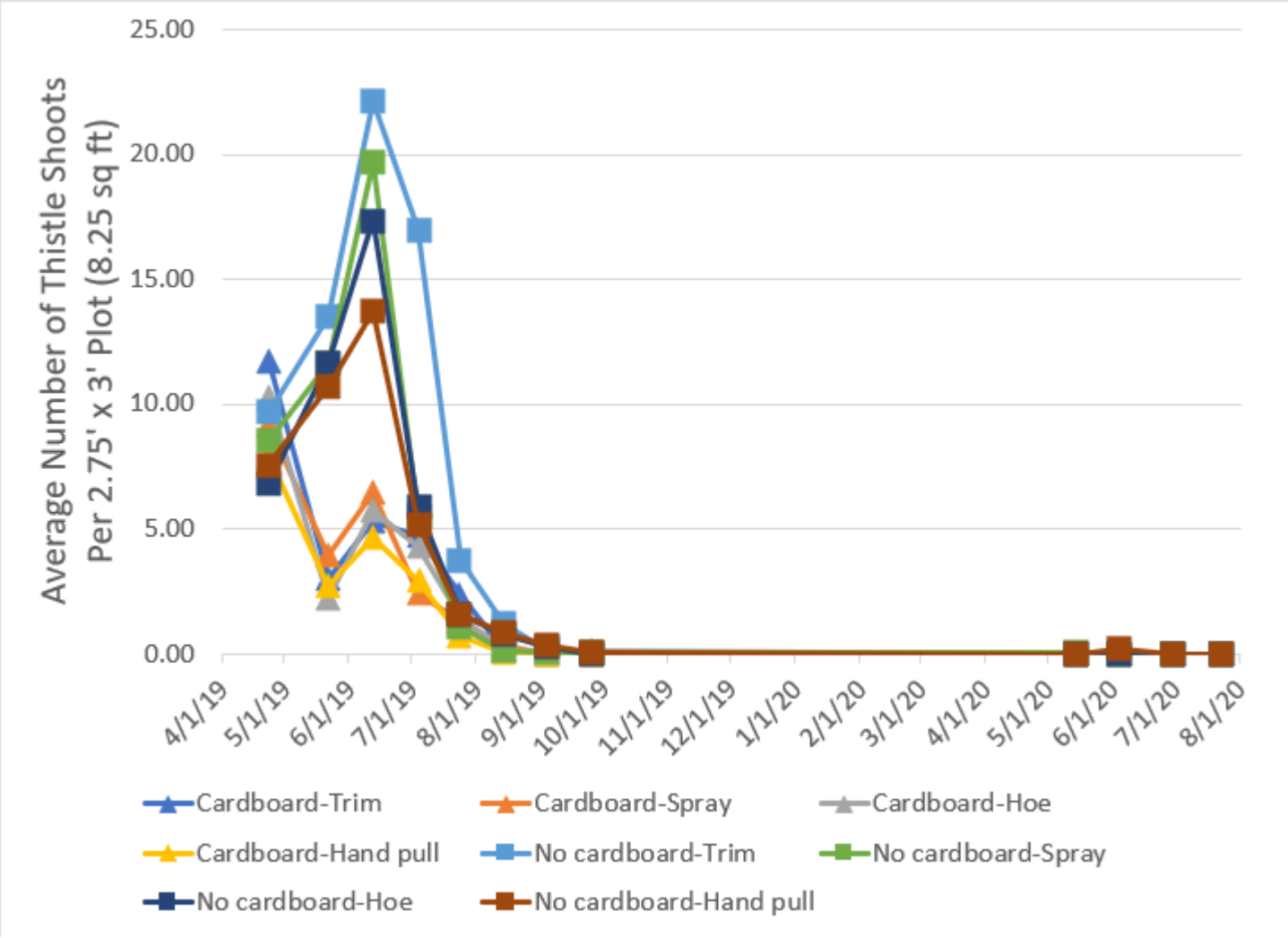

Figure 8. Average Thistle Shoot Density Under Different Treatments

Time and Cost. The graph below shows the time required to perform each weed killing treatment over the course of the experiment. In general, hand-pulling was most time consuming, followed by hoeing, and trimming and spraying were least time consuming. Plots mulched with cardboard required less time to apply weed-killing treatments, presumably because they had fewer thistles (and fewer other weeds). However, the initial cardboard mulch application required an additional 546 seconds per tree (not included in the graph below), which was greater than the time savings during the rest of the experiment for any of the weed killing treatments.

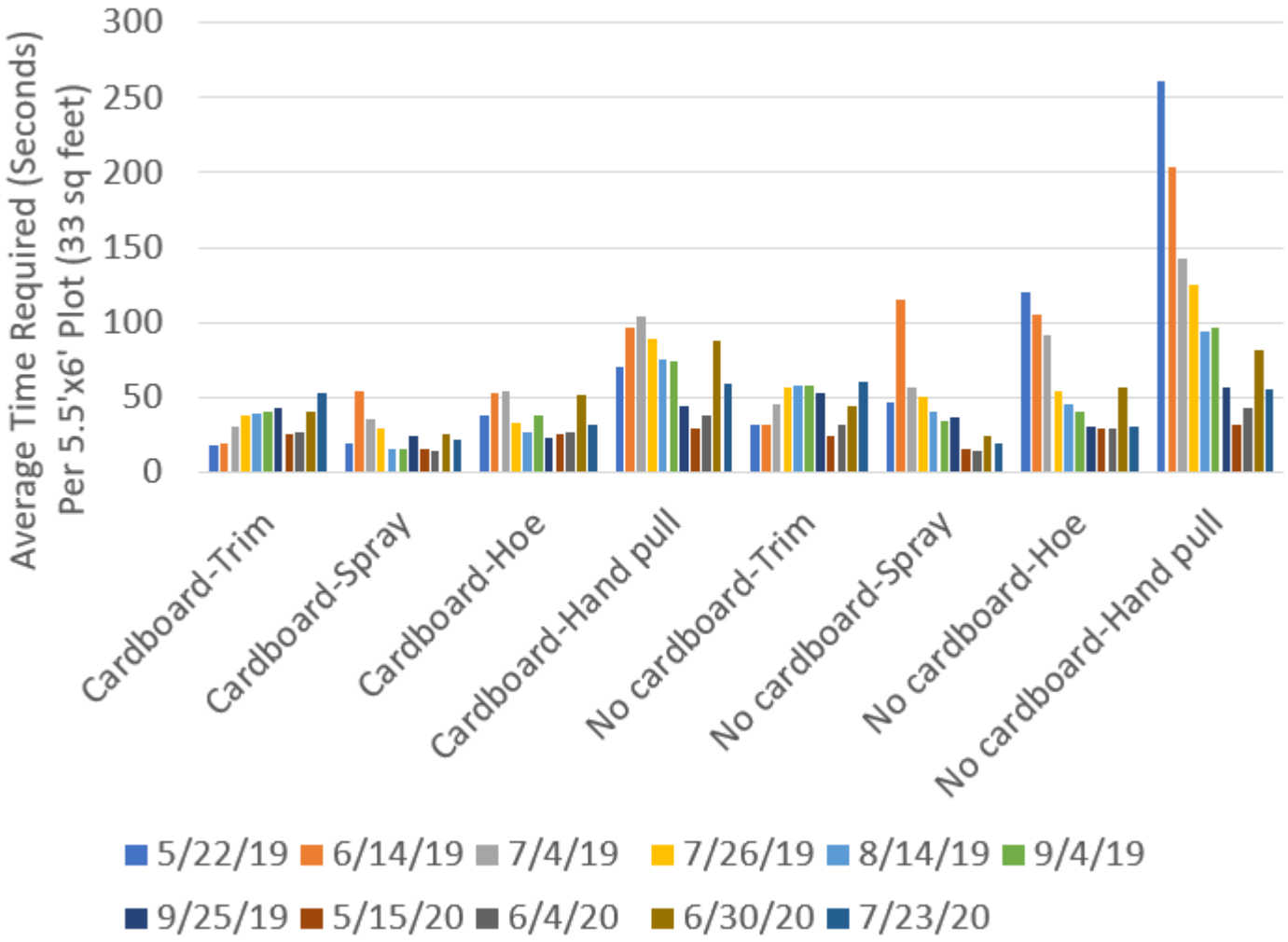

Figure 9. Time Required to Perform Weed Killing Treatments

The table below shows the cost per tree of applying each treatment over two seasons. Labor is priced at $15/hour, and the calculated costs also include the cost of herbicide and the cost of gas. Weed trimming without cardboard mulch was the least expensive treatment ($2.11 per tree). This is notable because this treatment actually resulted in the slowest reduction in thistle density. Spraying and hand pulling were the most expensive treatments; spraying required little labor, but the herbicide itself was very expensive. We assume that the recycled cardboard used in mulching is free (although the labor to apply it is not.)

Note that although cardboard mulch reduced thistle density and the time required to apply the subsequent weed killing treatments, it generally was not cost effective – the cost of applying the cardboard mulch outweighed the savings in reduced weeding time later in the year. Cardboard mulching was only cost effective in the spraying treatment, because the savings in herbicide costs with cardboard mulching justified the cost of mulching with cardboard.

Table 1. Cost per tree of applying experimental treatments over two seasons.

Treatment	Cost of Time To Apply Weed Killing Treatments ($15/hour)	Cost of Time To Apply Cardboard Mulch ($15/hour)	Cost of Herbicide ($37.44 per gallon)	Cost of Gas Used in Trimmer ($2.22 per gallon)	Total Cost Per Tree
Cardboard-Trim	$ 1.57	$ 2.28		$ 0.03	$ 3.87
Cardboard-Spray	$ 1.14	$ 2.28	$ 3.07		$ 6.48

Cardboard-Hoe	$	1.67	$	2.28						$	3.94
Cardboard-Hand pull	$	3.21	$	2.28						$	5.49
No cardboard-Trim	$	2.07					$	0.04		$	2.11
No cardboard-Spray	$	1.90			$	5.96				$	7.86
No cardboard-Hoe	$	2.64								$	2.64
No cardboard-Hand pull	$	4.96								$	4.96

Recommendations

Based on our experience, we would advise other growers that any method of killing Canada thistle shoots on a three week interval will hugely reduce shoot density within a single year and will virtually eliminate Canada thistle within two years. Prior to conducting this experiment, we had struggled with Canada thistle for years. We can firmly attest that killing the shoots 2-4 times per year (on approximately 5-10 week intervals) does not control this weed, and that patches will spread and proliferate under that regime. It is important to make it a priority to methodically and repeatedly attack patches on three week intervals.

In addition to the costs shown in the table above, there are other considerations in choosing a shoot killing method:

- If labor is particularly scarce in the late spring and summer, cardboard mulching may be justified if mulching can be done in fall or spring, thus saving time in the busier seasons.
- Trunk guards are probably essential when using a weed trimmer to prevent accidental damage to tree trunks. Weed trimming sometimes damaged the trunk guards on our trees.
- A gas weed trimmer has other downsides not shown in the dollars and cents analysis above: noise, vibration, gas fumes, operator fatigue, and pollution of the orchard with microplastics as the cutting string is used up. In addition there is the upfront cost of the weed trimmer and the need for periodic maintenance (not included in the table above). Using a diamond hoe may be a more desirable alternative for some growers.
- Although we did not collect data on non-thistle weeds, we noticed over the course of the study that weed trimming was less effective than the other treatments in controlling other weeds, particularly crabgrass and dandelions. This is probably the reason why the time required for the weed trimming treatment did not decline over the course of the study, as it did in the other treatments. As thistle populations decline, the value of each treatment will depend more on the effectiveness of the treatment in controlling non-thistle weeds.
- Some weed killing treatments tend to cause the bark mulch to decay more quickly than others. Although we did not collect data on this, hoeing obviously caused the most rapid breakdown of the mulch, probably by mixing soil with the bark and aerating the bark. Hand-pulling and weed trimming were intermediate. Mulch breakdown was slowest in the sprayed treatment. Rapid mulch breakdown is probably undesirable because more mulch will need to be applied in the future to maintain an effective mulch layer.

Regardless of the method used, eliminating a dense patch of Canada thistle is expensive and time-consuming. It's best to prevent patches from establishing in the first place. We recommend keeping Canada thistle plants from going to seed anywhere near the orchard. And if Canada thistle is present in sod in or near the orchard, practice regular close mowing to eliminate or suppress the thistles and make them less likely to spread into mulched areas.

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