COLORADO STATE UNIVERSITY
EXTENSION

Capric Acid: A Promising Next-Generation Herbicide for Organic Specialty Crop Production

Fact Sheet 0.314 | Crop Series | Production

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Weed management is a critical aspect of organic specialty crop production (e.g. vegetables, small fruits, ornamentals etc.). Weeds compete with the crop for light, water, and nutrients. They can negatively impact yield and overall quality in vegetable crops. For example, it is estimated that weeds can reduce vegetable yields by 45% or more depending on the level of weed pressure and the sensitivity of the crop to competition (Mennan et al., 2010). Specifically, weed pressure in peas reduced yields by 25-30%, while onion yields were reduced by 67% (Singh et al., 2019). Weeds that go unmanaged in an onion crop can impede bulb formation, which could lead to crop failure.

Fortunately, specialty crop producers have numerous weed management tools at their disposal. Preventative and cultural practices as well as chemical controls are a few options for managing weeds. In organic systems, integrated weed management (IWM) is the coordinated application of prevention tactics, avoidance mechanisms, monitoring systems, and weed suppression actions (Wilson et al., 2009). In addition, IWM affords producers the flexibility to tailor their plan based on the available management inputs, weed pressure, crop sensitivity, and the potential financial returns of their production system. High-value vegetable crops such as organic tomatoes or leafy greens sold at direct-to-consumer markets, for example, may warrant a larger financial investment in weed control inputs as compared to relatively lower value crops such as commodity grains. However, cost is not the only consideration in selecting a management input.

The herbicide inputs that are allowable in organic systems are different from those used in conventionally managed agricultural production systems. It is important to note that herbicidal inputs for organic systems are "allowable with restrictions." This means that preventative, cultural, and biological controls must be employed and documented before organic certification rules allow the application of any herbicide, even those labelled for organic use. In addition, that herbicide must be included in the organic system plan (OSP). If ever a question, ask your certifier first (i.e. before taking action).

*Terminology

Post-emergent - Herbicides applied after the weeds have emerged through the soil surface.
Non-selective - Herbicides that will burn down any green tissue on weeds or the crop.
Allowable with restrictions - Rule 205.206(e) under the National Organic Program (2020), requires that preventive, mechanical, physical, and other management practices are used (and documented) to control weeds before applying an herbicide, and the herbicide must be OMRI-approved and included in the organic system plan.

Quick Facts

- Post-emergent, non-selective herbicides can be used to manage weeds growing in and around certified organic food crops; they are allowable with restrictions.*
- The active ingredients caprylic and capric acid quickly "burn down" small annual and perennial weeds (≤2" in height).
- Annual weeds will generally die and not regrow, while perennial weeds will regrow in about 14-21 days.
- Pay close attention to the application volume. Organic herbicides are more effective at higher application volumes compared to many conventional herbicides.
- Scale-appropriate implements such as shielded-sprayers can be used to help protect the crop from herbicide injury with non-selective herbicides.

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Before an herbicide can be used, the organic system plan dictates that a full suite of IWM practices are also employed including: crop rotation, mulches, cover crops, tillage, and hand weeding. Herbicides should be used sparingly to control weeds in “trouble spots” such as field edges as in Figure 1 and along the plastic mulch-soil interface of vegetable crops grown in plasticulture as in Figure 2.

Figure 1. Untreated weeds growing along field edges; “trouble spot” (Tyler Mason Colorado State University).

Figure 2. Field bindweed growing along the plastic mulch/soil interface; “trouble spot” in a pepper crop (Tyler Mason Colorado State University).

Green Gobbler® and Weed Slayer® are derived from the active ingredients acetic acid (20%) and eugenol, respectively. Suppress®, Homeplate®, and Fireworxx are all caprylic and capric acid-based product formulations. Post-emergent means that these herbicides are applied to weeds that are actively growing above the soil line. Non-selective denotes that any plant tissue (i.e. green) contacted by the herbicide will be damaged. Therefore, care must be taken to avoid significant crop damage; only spray vegetation you want to kill.

Given their non-selective nature, there are several ways to avoid herbicide drift such as changing droplet size and avoiding applications under windy conditions, if using a sprayer, for example. A shielding hood could also be used to target weeds actively growing between crops rows. This is a plastic or metal hood with a spray nozzle in the center, which serves to cover the weed canopy with herbicide, while shielding the crop from drift. Figures 3 and 4 show an example of a shielded-sprayer used to control weeds in a milo crop. Note that the milo crop was protected from herbicide contact.

Table 1. Herbicide products, active ingredients, post-emergence, selectivity, and cost comparison.

Herbicide	Active ingredient	Post-emergent	Non-selective	Cost/acre[z]
Suppress®	Caprylic/capric acid	Yes	Yes	$450
Weed Slayer®	Eugenol	Yes	Yes	$300
Green Gobbler®	Acetic acid	Yes	Yes	$619

ZHerbicide product costs were based off of information available in 2020 for a single herbicide application at 50 gallons per acre; hand weeding costs were estimated at $294 an acre for an onion crop (Fennimore, 2019).

Figure 3. Shielded-sprayer applying caprylic/capric acid-based herbicide to weeds growing in a milo crop (Tyler Mason Colorado State University).

Figure 4. Field bindweed injury 1 day after treatment (DAT) in a milo crop following a shielded-sprayer herbicide application in Figure 3 (Tyler Mason Colorado State University).

Many herbicides for organic systems injure perennial weeds and can kill annual weeds (≤ 6" in height) through acid desiccation.
Depending on the product, desiccation occurs as quickly as a few hours or over 7-10 days. Here is an example video (Mason, 2020) documenting weed injury from post-emergent herbicide applications: https://www.youtube.com/watch?v=AFmGqBPJEZ0

The key to weed control using these products is 1) an appropriate volume of water to provide adequate coverage 2) an effective concentration for the weed height and 3) making the application during the critical period for weed control (CPWC) (Figure 5). Adequate volumes of water depend on the height and amount of weeds in the field; 80-125 gallons/acre is recommended for large weeds that are 12-18" in height (Anonymous, 2015); no less than 30 gallons/acre is recommended for weeds that are <1" in height. Many of these herbicide formulations offer low, medium, and high application concen-trations for weeds of varying height/maturity. For example, caprylic/capric acid (as Suppress®) can be applied at 3, 6, and 9% (v/v) concentrations (Anonymous, 2015). Still, it is important to note that the smaller the weed, the better control one can expect, even with the adjustable rates. Always check the label for legal use rate caps. It is generally legal to apply lower than labelled rates, but illegal to go higher.

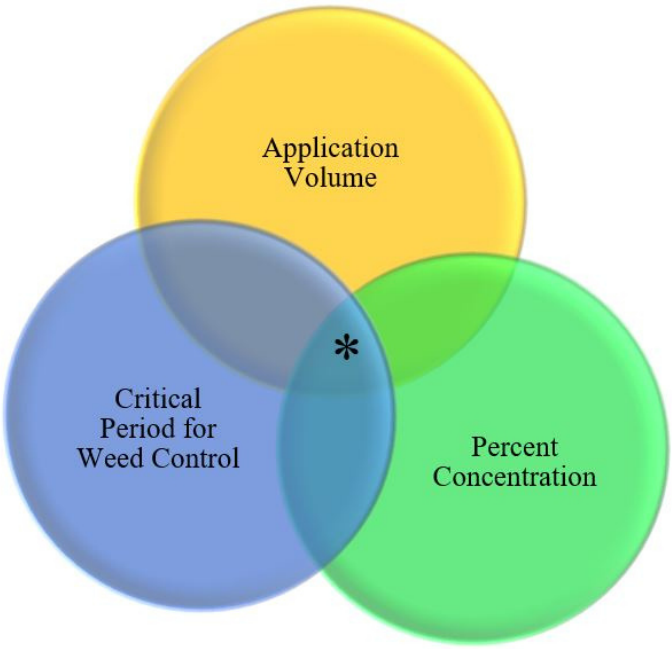

*Figure 5. * Optimal weed injury is the result of applying an adequate volume, at an appropriate percent concentration during the critical weed injury period.*

In a demonstration sweet corn plot, weed control was achieved by making herbicide applications using an 80 gallons/acre spray volume and a 9% (v/v) caprylic/capric acid concentration during the critical period for weed control. The CPWC is the period of time relative to the crop growth stage when unchecked weeds lead to yield losses. Weeds emerging before or after this time-period do not threaten yield losses (Knezevic, 2020). In sweet corn, this is between the four-leaf (V4) and eight-leaf growth vegetative stage (V8) (Williams, 2006). In onions, the CPWC is between 15 and 45 days after emergence (Qasem, 2005). Although, some think that the CPWC in onions should extend to the whole length of the season (Ontario, 2009).

Research examples

An evaluation of post-emergent herbicides was conducted in commercial onion grower's field under conventional management located in Adams County, Colorado during the 2019 growing season. As depicted in Figure 8, we use the term weed injury in this example because herbicides used in organic systems may not achieve complete weed control (i.e. death) .The results indicated that higher application volumes lead to significantly more weed injury (Figure 6). Application volumes less than 50 gallons per acre (GPA) did not meet the minimum acceptable level of weed injury ≥50%

(Patton et al., 2019). Similarly, the weed injury increased with increasing percent concentrations of caprylic/capric acid (Figure 7).

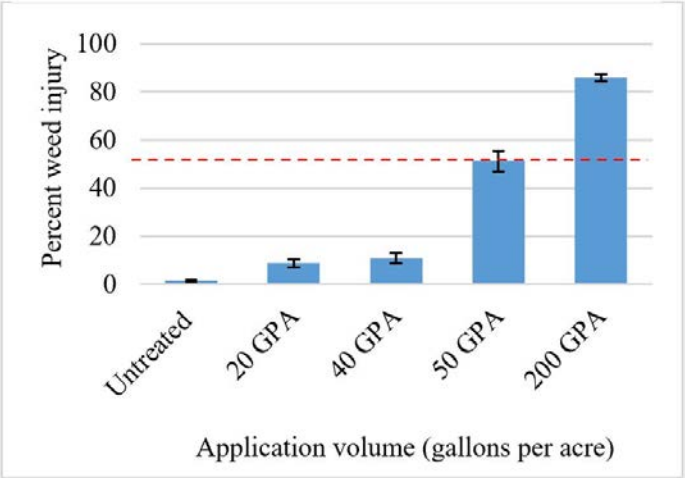

Figure 6. Caprylic/capric acid herbicide lead to more weed injury with increasing concentrations of product applied; red line indicates the minimum acceptable level of weed injury (>50%).

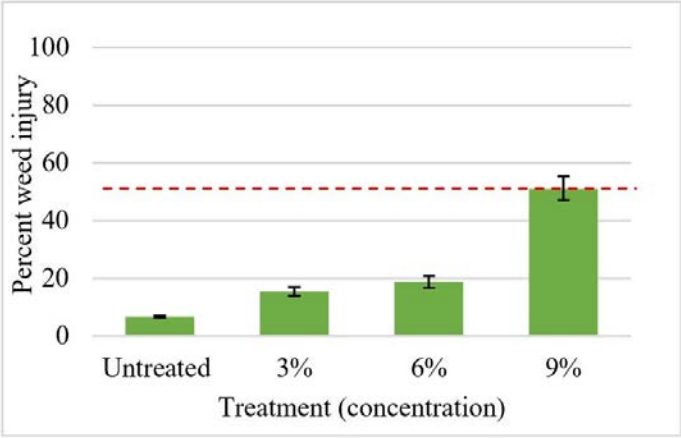

Figure 7. Caprylic/capric acid herbicide lead to more weed injury with increasing volumes of product applied; red line indicates the minimum acceptable level of weed injury (>50%).

There is a tradeoff between weed injury and crop injury when applying post-emergent, non-selective herbicides. Applying a caprylic/capric acid herbicide lead to increased visual percent crop injury (Figure 8) with increasing treatment concentration (Figure 9) and application volume (Figure 10) . For comparison, the acceptable estimates of crop injury following an oxyfluorfen treatment, which is commonly used to control weeds in a conventionally managed onion crop is 22% (Herrmann et al., 2017). It is important to mention that early-season onion injury from herbicides is often transitory and does not necessarily result in yield reductions. There were no statistical differences in terms of total onion yield following early post-emergent application of oxyfluorfen or any of the organic approved herbicides included in the study (data not shown).

Figure 8. Post-emergent, non-selective herbicides were broadcast over the top of two-leaf stage onions lead to both weed and crop injury (Tyler Mason Colorado State University).

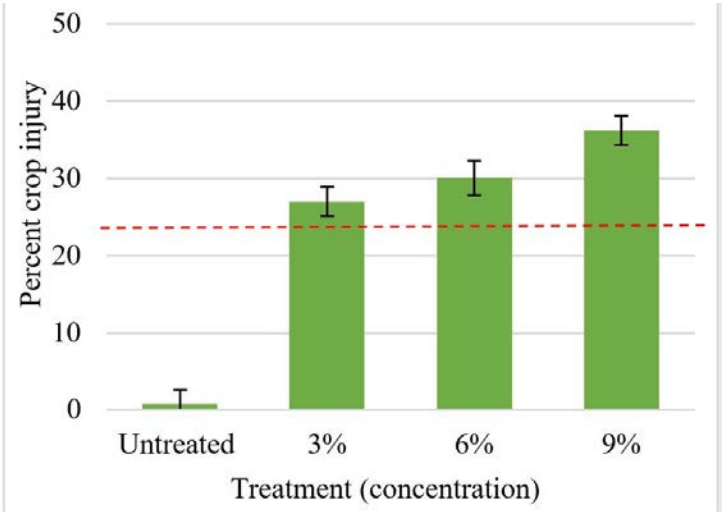

Figure 9. Percent onion injury (4 DAT) for three application volumes of caprylic/capric acid applied at 9% concentration; red line indicates acceptable visual crop injury following an application of the conventional herbicide oxyfluorfen (Herrman et al., 2017).

It is also important to mention that no adjuvants were added to the herbicide solutions in this study. Adjuvants are sometimes added to herbicide solutions in order to improve product efficacy and for a range of other purposes. However, not all herbicides require adjuvants for optimal efficacy, and individual herbicides may require (or be incompatible with) specific adjuvant types. Before using an adjuvant, check the herbicide label for any guidance or requirements, or consult with your retailer if the label does not provide guidance. For example, the addition of orange or canola oil did not improve herbicide injury from an acetic acid application to weeds (Webber et al., 2018).

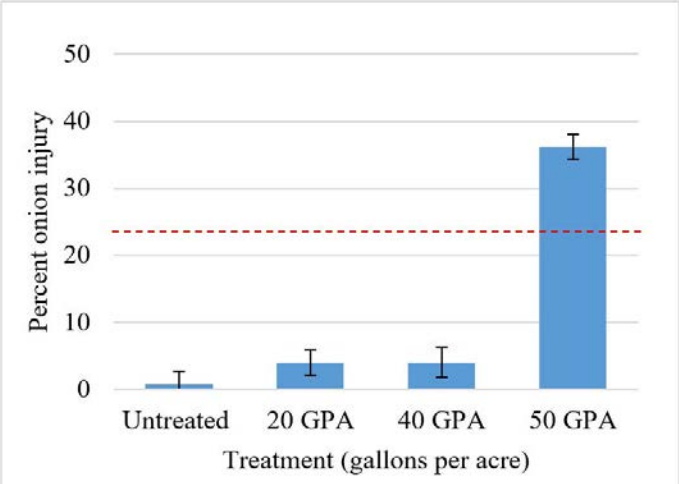

Figure 10. Onion injury (4 DAT) for three treatment concentrations of caprylic/capric acid applied at 50 gallons per acre; red line indicates acceptable visual crop injury following an application of the conventional herbicide oxyfluorfen (Herrman et al., 2017).

Conclusions

Research indicates that caprylic/capric acid-based herbicides applied at 9% concentration lead to adequate (≥50%) weed control to provide a useful tool for weed control in an IWM system for organic specialty crop production. It is advisable to apply at the 9% rate for weeds >6" in height. Consider starting at 50 gallons per acre and increase the spray volume up to 125 gallons per acre in order to address the suite and size of weeds on your farm and avoid hitting the cash crop.

Cost is an important consideration. Herbicides for organic systems are not cheap; an application of 50-gallons per acre ranges in cost between $300 - $620 per acre. This is more than the average $294 per acre it costs to hand weed. However, if labor is limited, one might consider an herbicide application, especially in specific areas. Keep in mind that herbicides for organic systems are allowable with restrictions, so always check with your certifier first. Some anticipated general uses might include cleaning up "trouble spots" such as field edges and weeds growing along the fence row or the plastic mulch-soil interface of a vegetable crop in plasticulture.

Specific uses include using a shielded sprayer to control small weeds (≤2" in height) at the base of milo or a sweet corn crop that is beyond the four-leaf stage. Another specific use includes broadcasting caprylic/capric acid over the top on an organic onion crop to control weeds, especially early in the growing season when the crop is most vulnerable. As long as there is a weed control need and selectivity can be achieved by placement (e.g. shielded sprayer, careful hand weeding etc.) caprylic/capric acid could be a useful tool for high value organic production across the board. Unlike many conventional products, the labelling on caprylic/capric acid is broad. Therefore, it would be advisable for growers to do some of their own testing too.

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