Weed Removal in Organic Vegetable Crops. Steven A. Fennimore*, University of California, Davis, at Salinas CA. *Corresponding author safennimore@ucdavis.edu

There were about 100,000 acres of organic vegetable crops in California in 2012 (Klonsky and Healy 2013). Vegetable crops consist of dozens of crops and have varying weed management systems based on the needs of the crop. There are few effective organic-compliant herbicides available for use by organic producers, and herbicides play little or no part in commercial organic vegetable production. Important weed management tactics for organic vegetables include crop rotation, stale seedbed preparation, cultivation and hand weeding. Traditional inter-row cultivation plays a very important role in organic vegetable production systems. This method of cultivation leaves the seedline untouched and thus hand weeding is required to control weeds near the crop plants. However, agricultural labor shortages are common and growers report difficulty in finding enough people for many farm tasks including hand weeding. Therefore, there is an overwhelming need to find cost-effective technologies to control weeds in organic vegetables.

One of the more successful strategies for organic vegetable fields is a long-run focus on limiting production of weed seed, thus keeping the weed seedbank population low in the field. This means removing weeds during the crop production season and disking down weeds before they reseed during fallow periods. Hand weeding is the most effective method of weed control close to the crop plants in-season, but is increasingly expensive. Among new tools available to organic vegetable producers are intra-row automated cultivators.

There are at least three brands of automated cultivators, also called "intelligent cultivators": Robocrop, Robovator and Steketee IC. These cultivators have machine vision systems, i.e., cameras linked to a computer, that detects the row pattern and identifies the crop based on planting pattern. Plants that are not in the row pattern are assumed to be weeds and targeted for removal. The information about the location of the crop is used to control an actuator – in this case a cultivator blade, that removes the weeds around the crop including the intra-row space, much the same as a human hoe hand.

Cultivator blades and weeding knives are not new technology. What is new is the combination of steel cultivator knives with automation technology to create a new type of weed control tool. The device that contacts and kills the weed is called the "actuator". Cultivator knives are just one such actuator – there are other possibilities such as abrasion (i.e. sand blasting), flame, superheated steam, hot oil, lasers, stampers and high pressure water jets. Intelligent cultivators work well in low density crops like lettuce, pepper and tomato where there is adequate space to separate the crop plants and differentiate them from weeds. However, high density crops such as carrot and spinach will require a different approach such as a grid spraying system. In the grid system the automated weeder would identify the weeds and differentiate them from the crop. The system would then control the weeds with a physical tool such as a flame burst or abrasive grit targeted to a small spot such as a 0.5" by 0.5" square.

Another strategy that we have been working on is use of a banded steam application to control weeds in the seedline. By injecting steam in the band for sufficient time to raise the soil temperature to over 150°F for several minutes we have achieved over 90% weed control in lettuce. This is an experimental strategy and our research is ongoing. However, our objective is to apply

steam at a speed of at least 1 mph and a cost of treatment of no more than $100 per acre. This method also provides suppression of lettuce drop disease, a serious soilborne disease of lettuce.

Literature cited

Klonsky K, Healy B (2013) Statistical review of California's organic agriculture 2009-2012. Agricultural Issues Center, University of California