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Yuma Beds for Early Cantaloupe Production

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Cantaloupe is an economically important crop to the state of Arizona. Since 1992, harvested acres of Arizona cantaloupe has ranged from 13,200 to 23,000, averaging 24.8% of national production, making Arizona the second largest cantaloupe producing state in the country, next to California (Vegetables: USDA-NASS, 2022). Cantaloupes produced in the Southwest United States are traditionally harvested from May through November, with the highest market values associated with the earliest harvested fruit in spring and latest harvested fruit in fall (Figure 1) (Market News Report: USDA-AMS, 2022).

Fulfilling cantaloupe contracts as early as possible in spring is highly desired by the grower because it allows them to capitalize on the increased market value for their melon crops, which competes against higher priced imported melons from Central and South America. In the Yuma Valley, Arizona, and Imperial Valley, California, planting dates can occur as early as December; however, the risk of poor germination, crop loss to frost, and poor fruit quality is high, due to low heat units (M. Russell Jr., personal communication, May 13, 2020). Cantaloupe germination is affected by heat, with slow to no growth occurring at 53°F, and maximum vigor at 95°F (Bakhshandeh & Gholamhossieni, 2019). Specialized cultivation techniques have been developed by growers to capture heat and warm the soil during the cooler winter months, providing the microclimate needed to increase germination and seedling vigor, resulting in more marketable fruit earlier in the season.

A 'mid-bed-trench' system is often used to heat the seedling zone, which entails seeding a shallow trench made in the middle of a raised bed, which is overlaid with a narrow strip of clear plastic film. The film captures heat and insulates the seedlings developing underneath. Holes are later punched in the film to allow seedling hardening off then the plastic is completely removed late February to mid-March. The trench is flattened via cultivation and the cantaloupes finish out the season on a flat raised bed (Meister, 2004; M. Russell Jr., personal communication, May 13, 2020). This method of production is effective at increasing early germ vigor, but expensive, requiring added material, tractor passes, and labor costs.

Another technique used to produce early season melons is the 'Yuma bed' system. The origin of this technique is unknown, but it has been reported to be consistently used

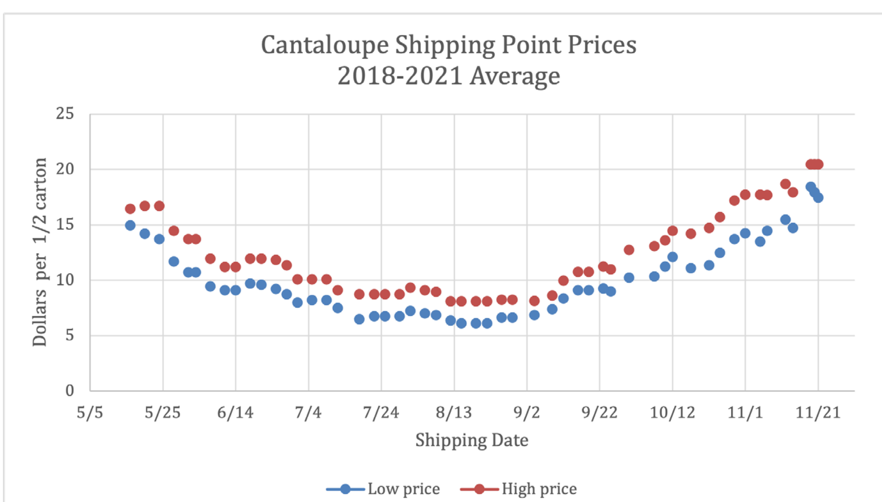

Figure 1. Cantaloupes are priced differently during the year. Greatest sales value occurs in early spring and late fall. Note: Chart depicts: Central and Western Arizona, and Imperial, Palo Verde, and San Joaquin Valleys. 9s size grade (9 melons per box), non-organic, price: (dollars per ½ carton).

in Imperial, California, and Yuma, Arizona, since the 1920s to grow early melons and sweetcorn (C. Hunt, personal communication, April 28, 2020; M. Russell Jr., personal communication, May 13, 2020, C. Elmore, January 31, 2022). Cantaloupe grown on Yuma beds involve seeding on the south side of a sloped raised bed then centering the bed around the plants after emergence. The benefit of this method is twofold: (1) the south facing angled slope intercepts more sunlight than a traditional flat-topped bed, which warms the soil surface, increasing germination vigor and providing greater frost protection (Figure 2); (2) the seed-line is higher above ground level than a traditional flat-topped bed, which is thought to reduce temperature loss from ground conductance.

Different bed angles are used by different growers, but typically range from 28-37 degrees (Meister, 2004, C. Hunt, personal communication, April 28, 2020). Growers must make several considerations when selecting the desired pitch of their beds: latitude, time of year, azimuth orientation, angle of repose, and crop workability. With the recent rise in popularity of solar panels used to generate electricity has come the interest in determining optimal light interception angles in which to orientate panels. The National Renewable Energy Laboratory's PVWatts® Calculator can be used to determine different solar energy interception rates for different angles, located at specific geographic locations, during specific times of the year. Solar energy interception rates were calculated for Yuma, Arizona, during December – February timeframe (Figure 3). Results indicated solar panels with angles of 50-60 degrees to be the most effective at light energy interception.

Growers use specialized equipment for planting and cultivating Yuma beds that vary from company to company, but most adopt the techniques listed below and outlined in Figure 4:

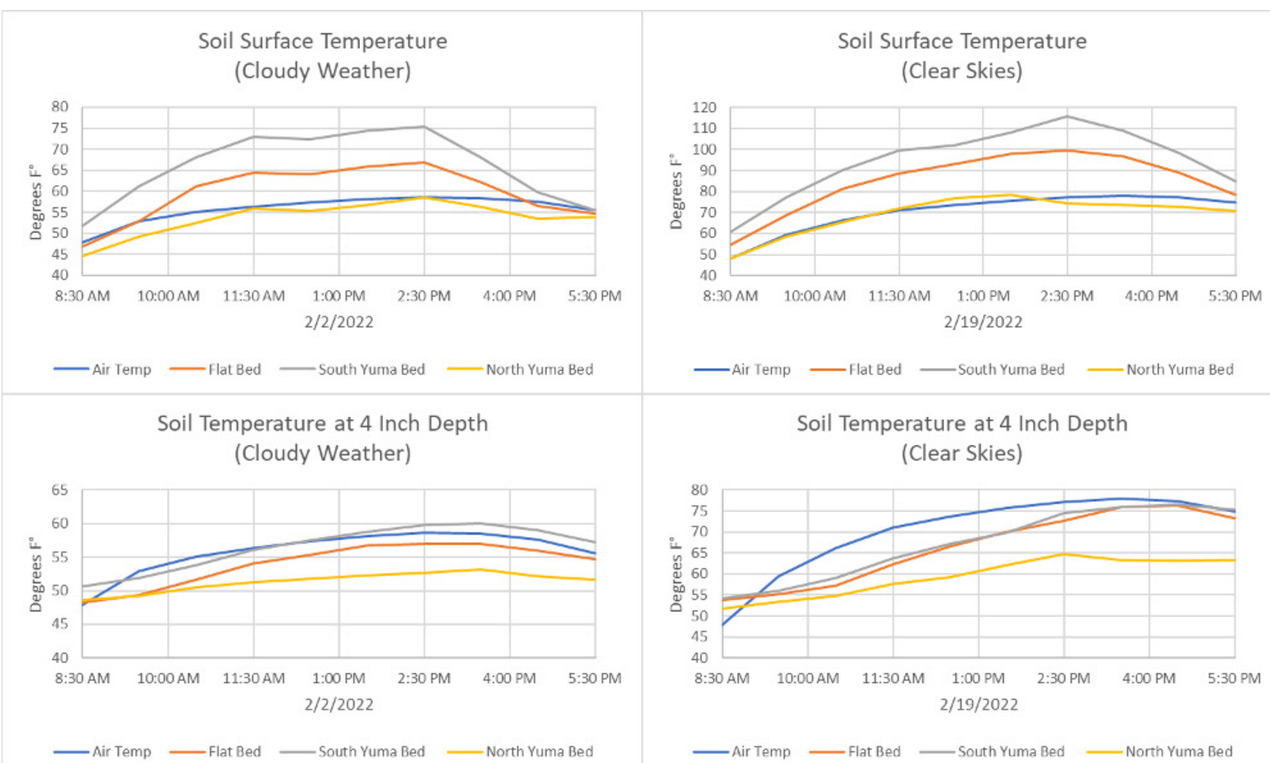

Figure 2. Surface and subsurface soil temperatures of Yuma beds and flat beds, collected with handheld infrared and four-inch probe thermometers, on cloudy and clear sky days.

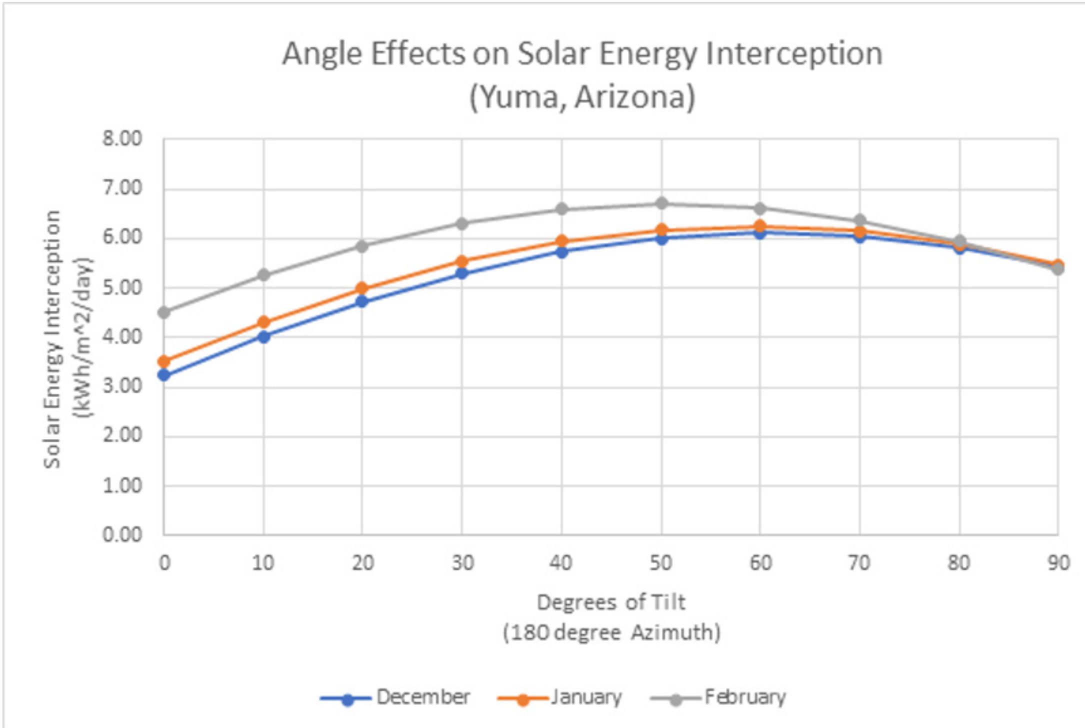

Figure 3. PVWatts® software calculations for solar interception rates of different degrees of tilt for solar panels located in Yuma, Arizona, during the winter months of December-February.

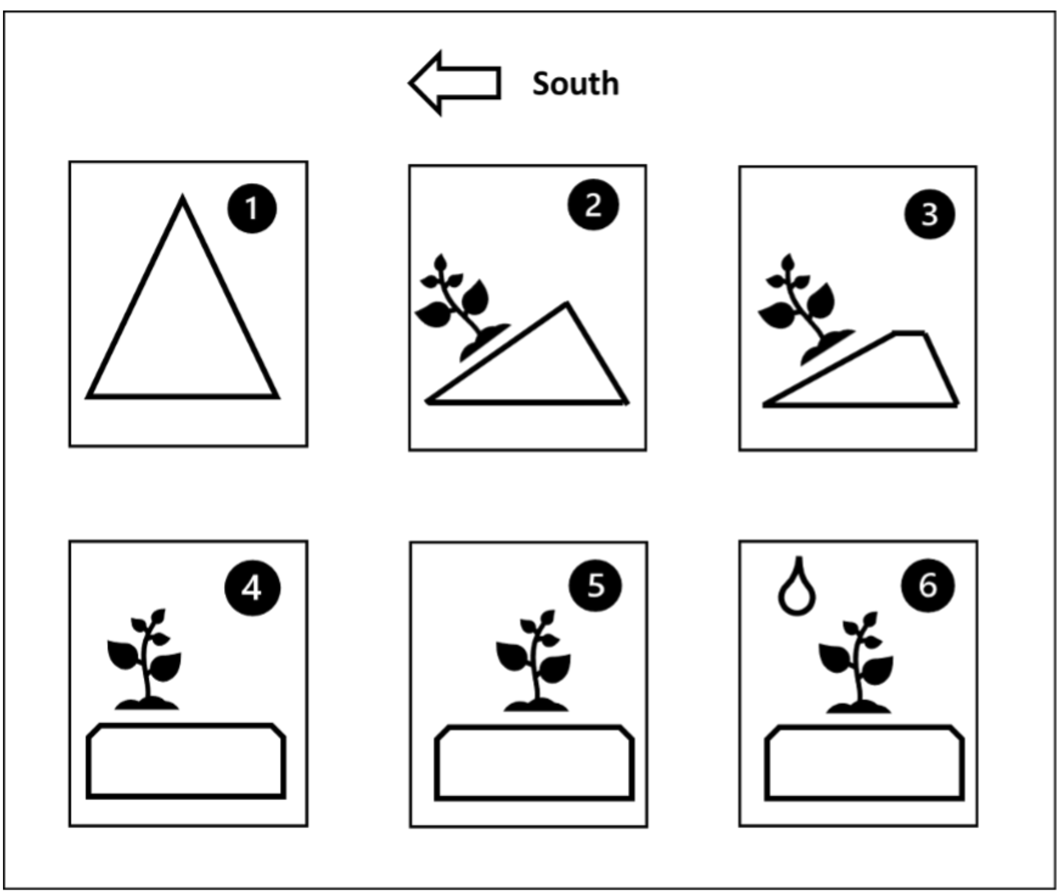

Figure 4. Stages of the Yuma bed cantaloupe production system. (1) List, (2) Seed, (3) Cap, (4) Shape, (5) Center, (6) Layby. Beds are seeded on the southside of listed melon beds to capture more solar heat and facilitate germination. Once plants are established and the threat of frost is gone beds are remade around plants, centering them.

1. List: A standard double border disk is used to make a triangular shaped, 80 or 84-inch 'listed' melon bed, with an east-west alignment and a south facing slope. Traditional raised bed production would involve 'knocking down' the listed beds to form 80 or 84-inch flat-topped raised beds; however, Yuma beds keep the listed beds intact for seeding.

2. Seed: A custom fabricated Yuma bed planter (Figures 5-7) is used to shape, smooth, and plant the south side of each listed bed. The inclined blade pushes soil over the top of the triangular peak onto the north side, shaping the south side to the desired pitch. A vacuum planter located behind the inclined blade is used to sow a single seed-line, ~30 inches above the base of the bed. Planting depth is very shallow, with just enough soil coverage to keep the seed in place. Western Shipper cantaloupe varieties are seeded at closer spacing than Harper and later thinned to 12-17 inches, while Harper types are typically planted-to-stand because of higher seed costs. Sprinkler irrigation is used for germinating the elevated seed line. (Figure 8).

Figure 5. Rear view of a Yuma bed planter used to shape and plant angled raised beds (Coronation Peak, 2020).

Figure 6. Right-side view of a Yuma bed planter used to shape and plant angled raised beds (Coronation Peak, 2020).

Figure 7. Left-side view of a Yuma bed planter used to shape and plant angled raised beds. The planter has two blades and vacuum planter units, so that two beds may be seeded at the same time. Equipment is rotated after each pass to account for field asymmetry (Coronation Peak, 2020).

Figure 8. Yuma beds with seed line emergence on south side of bed. (SMT Melon Company, 2020).

3. Cap: After the plants are established, the tops of the triangular beds are 'capped' by pushing soil above the plant-line to the north side of the bed with a pitched disk mounted to the front of the tractor (Figure 9). During the same pass, a rear mounted disk and/or side-knives (Figure 10) are used to add more soil to the south edge of the bed, removing the southside furrow, and breaking up clods that may have fallen on the north side during the capping process. When this pass is completed, a flat-topped raised bed is made, but the plants remain off centered on the bed, located approximately 12 inches from the south side of the bed edge (Figures 11 & 12).

Figure 9. Bed tops are 'capped' by pushing soil to the north side of the bed with a set of adjustable pitched disks that rotate to accommodate field asymmetry (SMT Melon Company, 2020).

Figure 10. Banana sweeps and disks used to evenly distribute the soil on the north side of the plant-line during the 'capping' pass. Two sets of implements with different orientations are alternatively raised or lowered to account for asymmetrical field layout (SMT Melon Company, 2020).

Figure 11. Offset cultivation during the ‘capping’ pass (SMT Melon Company, 2020).

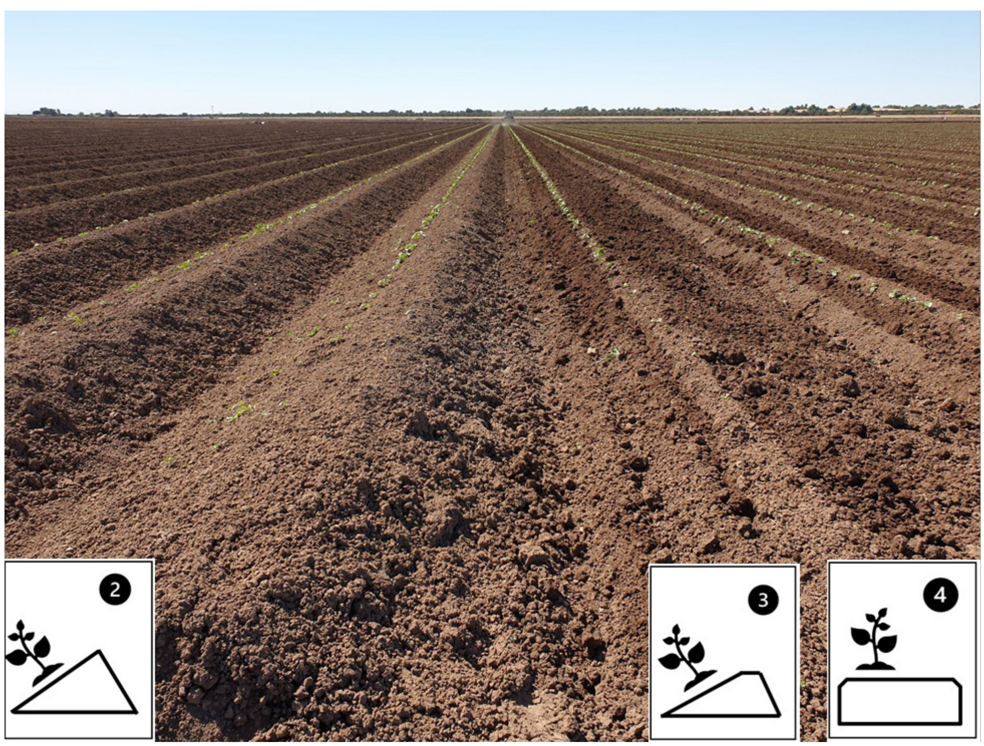

Figure 12. Before (photo left) and after (photo right) the ‘capping’ pass. The peak of bed is pushed to the north side to create a flat top bed with an off-center plant line (SMT Melon Company, 2020).

4. Shape: Another pass is sometimes made with banana sweeps to evenly distribute the capped soil on the north side of the bed and break up excessively cloddy soil (Figure 13).

5. Center: Pitched disks and modified moldboard plows are used to push soil onto the north side of the bed, up to the base of the plants, further leveling the north side of the bed and removing the original north side furrow (Figures 14-16). During this pass new north and south furrows are

Figure 13. During the ‘shaping’ stage the soil on the north side of bed is further broken up and moved to the north side of bed with two sets of ‘banana sweeps’ that are alternatively raised and lowered to fit asymmetric field conditions.

Figure 14. Pitched disks used to push soil to the edge of the plant-line on the north side of bed and rebuild the furrow around the newly centered plant-line (Coronation Peak, 2020).

Figure 15. Ground is worked to center the seed line in the middle of the bed. Two sets of implements are set up at different orientations, which are alternatively rotated to account for asymmetrical field layout (SMT Melon Company, 2020).

Figure 16. Beds are remade around a newly centered plant line with rotating moldboard plows (SMT Melon Company, 2020).

made around the plants, centering the plant line in the middle of the bed.

6. Layby: A layby herbicide application is usually made, which may include, or be followed by, a pass with a cultipacker, with ring rollers, 'wiggle tails', and bolas to smooth bed tops and pack the bed edges and furrows. Furrow irrigation is then used for the rest of the season (Figures 17-19).

7.Rotate: It is important to note that Yuma beds follow an asymmetric field layout, with an off-center seed

Figure 17. Cultipacker with ring rollers, "wiggle tails", and bolas used to smooth newly formed bed tops and compact the furrow (Coronation Peak, 2020).

Figure 18. Cultipacker with ring rollers, shanks, and weights are used to clean the soil around the plant line and compact the furrows (SMT Melon Company, 2020).

Figure 19. Cultipacker used to smooth bed tops and compact furrows (SMT Melon Company, 2020).

line. Asymmetric beds require implements with a fixed orientation be used in a single direction with an added no-work return pass (deadheaded), or adjustable implements be used that move to match field design for continuous use down and back through the field. For example, the blade on the Yuma bed planter is used to plant the south side of bed going down the field then rotated 180° to plant the south bed of the return pass, without adjustment it would plant the north slope on the return pass (Figure 20). Adjusting equipment involves either rotating implements

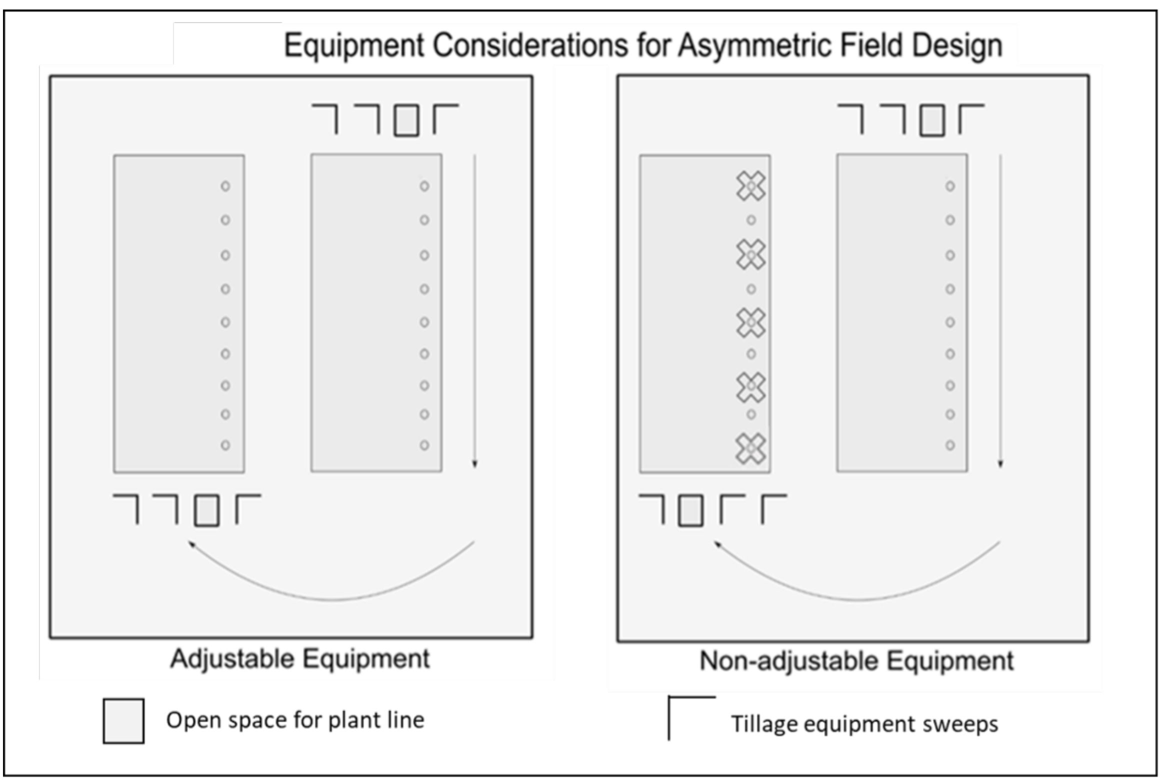

Figure 20. Asymmetric bed work either uses implements with a fixed orientation applied in a single direction, requiring a 'deadheading' return pass, or adjustable implements that move to match field design for continuous passes down and back through the field. The left image demonstrates use of an adjustable cultivator with two sets of differently orientated tillage sweeps, which are alternately raised and lowered after each pass down the field. The right image illustrates damaged plants from fixed equipment improperly used in a continuous pass; the pass down is correct, but the return orientation does not match the field layout and would destroy the crop.

to different angles or using a second set of differently orientated fixed implements that are alternatively raised or lowered with hydraulic switch boxes (Figure 21).

By using the mid-bed-trench and Yuma bed systems cantaloupe growers of the southwest can heat their soils better than traditional flat raised beds and more easily produce higher value early spring melons. Yuma beds should be studied more thoroughly and improved upon by optimizing variables such as slope grade and facing. Further study should be done combining Yuma beds with the mid-bed-trench system to create a 'Yuma-bed-trench' system, where beds are listed and trenched on the south side of the slope then seeded and covered with clear plastic mulch. This might, in theory, capture more solar heat than traditional mid-bed-trench systems, which are planted on flat beds. In addition to the south-side heating effects noted in this paper, a cooling effect was observed on the north side of the bed (Figure 2), which has been experimented with in industry to cool heat sensitive crops in the summer (C. Hunt, personal communication, April 28, 2020). Further research should be conducted to optimize synergy of bed shape, seed line placement, and crop temperature requirements with Yuma beds.

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Figure 21. Continuous seeding and tillage of asymmetric beds either requires two sets of differently orientated implements that are raised or lowered to match field orientation ('banana sweeps' on image left), or equipment that is rotated 180 degrees to match field orientation (pitched disks on image right) (Coronation Peak, 2020 & SMT Melon Company, 2020).

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