A Preliminary Comparison of Organic, Grafted, and Conventional Cantaloupe Production under Subsurface Drip Irrigation

Russell Tronstad, Ph.D.
Professor and Extension Specialist, Department of Agricultural and Resource Economics
University of Arizona
Chieri Kubota, Ph.D.
Associate Professor
Department of Plant Science and Department of Agricultural and Biosystems Engineering
University of Arizona
Michael McClure, Ph.D.
Professor, Department of Plant Sciences
University of Arizona
Mary Olson, Ph.D.
Professor and Extension Specialist, Department of Plant Pathology and Microbiology
University of Arizona

Introduction

Identifying a specialty or niche production process that a firm can conduct better than the competition (creating a competitive edge) is a potentially profitable niche marketing strategy. An example of this is melon producers who become successful early adopters of grafting and producing organic melons superior to those of the competition in terms of quality and cost of production. Production opportunities may also exist through crop rotations, virgin soils, or production zones that are isolated from other areas. Because insects and diseases are not confined within property boundaries, seeking a favorable production niche is central to identifying a favorable niche market.

Subsurface Drip Irrigation (SDI) provides unparalleled irrigation efficiency, but the initial capital investment for installing SDI is relatively high. Crop rotations are also somewhat limited with SDI, due to the need for specialized equipment and a high value crop to justify the expense of SDI. However, SDI provides some distinct production and harvest advantages for some "high value" crops, including melons (Boyhan, Kelley, and Granberry, 1999). For example, "first fruit" melons can be harvested while irrigation is occurring through the drip lines to nourish the quality and increase the quantity of melons that will be ready for harvest later in the season. SDI also allows for chemicals to be applied directly to the soil through the drip line, minimizing the loss of volatile chemicals, such as chloropicrin, to the atmosphere.

Conventional cantaloupe production in the West under SDI has traditionally utilized soil fumigation to control soil-borne pests, fungal diseases, and certain weeds. A particularly injurious combination is *Meloidogyne incognita*, and root rot and vine decline caused by several fungi including *Monosporascus cannonballus* and *Macrophomina phaseolina*. These fungal diseases constitute a serious threat to continued cultivation of melons in the desert production regions of southern California and Arizona. Fungicides registered for use on cantaloupe for these diseases are expensive and do not always give adequate protection, especially in highly infested fields. Preplant fumigation with 1,3-dichloropropene is effective for management of root-knot nematodes, but is not active against fungi. Preplant fumigation of pathogen-infested fields with methyl bromide has proven efficacious for disease control, however, as methyl bromide depletes the stratospheric ozone layer, its use is being phased out and critical use exemptions are required to use it as agreed to by the Montreal Protocol and the Clean Air Act (U.S. Environmental Protection Agency, 2006). The use of methyl bromide must be discontinued in the U.S. by 2008, and worldwide by 2015. Thus, alternative disease management strategies are needed.

One tool under exploration is grafting. Melons grafted to root stocks of certain squash and other cucurbits may be more resistant to fungal diseases and soil-borne pests. As grafting does not require the use of synthetic pesticides, the technology can be used to grow melons organically. Grafting of young vegetable seedlings has been utilized in Asia for many years, but it wasn't until the development of "tube grafting" in the early 1990s (Itagi, Nakanishi, and Nagashima, 1990) that the speed and success of grafting was suitable for adoption by commercial propagators. In addition, the use of semi-robot and robotic equipment makes grafting vegetables on a large scale for commercial production more feasible than it was prior to this technology (Kurata, 1994). Figure 1 shows a flat of grafted melons, with plastic clips at the graft joint, ready for transplanting to the field.

Melon Field Trials

To evaluate the viability of grafting technology for cantaloupes, field experiments were conducted in the fall of 2007 in Arizona for both organic and conventional practices using 1) direct seeding of Olympic Gold, 2) Olympic Gold grafted on Tetsukabuto, 3) Acclaim grafted on StrongTosa (interspecific hybrid squash), and 4) transplants of non-grafted Olympic Gold. The planting for the direct seeded Olympic Gold occurred on July 16. Transplant dates followed direct seeding by a few days with grafted Olympic Gold on July 20, grafted Acclaim on July 28, and non-grafted Olympic Gold on July 26. Ideally, all trials would be planted on the same day, however, difficulties with shipment orders as scheduled did not allow for plantings of all trials to occur on the same date. Four replications of each trial were completed.

Figure 1: Grafted Melons

Figure 2: Manual Planting of Transplants

Transplants were primarily placed in the ground by hand, as shown in Figure 2, because limited success occurred with a machine adapted to aid with transplanting. A plastic cover was placed on the top of each bed over the subsurface drip line, which is buried 23 centimeters below the surface. The plastic serves multiple purposes in the production system: it helps retain volatile chemicals in the soil that are applied through the drip system, provides weed control, and retains moisture in the planting bed for seedlings. The plastic is sprayed with a white wash for fall melons so that the soil beneath the plastic would stay cooler than the bare ground, while black plastic is used in the spring to retain the heat and warm the soil. A hole is burned into the plastic by the planting machine for direct seeded melons.

As transplanting requires much more labor than direct seeding, it was noted that organic production was only feasible for this operation due to the ability to move all of their labor from the conventional side of the farm to focus on the smaller number of organic acres. Having a large labor pool available to address production issues that would arise with organic production, whether transplanting, weed control, or pest control actions, was important for the organic side of the operation. Thus, some complimentary aspects of the labor supply were found to exist from producing both conventional and organic melons at the same time.

Even if yields are not adversely impacted from root knot nematode *Meloidogyne incognita*, fruit quality may suffer in the form of lower sugar levels or brix percentages. Figure 3 illustrates how root-knot nematode and weed control can be an issue in organic fields. Weeds and nematodes are generally not as much of an issue using virgin land or coming off certain crop rotations, however, many rotational crops that may be good for control of weeds and nematodes may not be very marketable or fit into the production system. For example, alfalfa could serve as a rotation crop with melons (most alfalfa grown in Arizona is resistant to *M. incognita*), but is a relatively bulky commodity that cannot be shipped too far and still be cost competitive. Additionally, alfalfa is not readily adaptable to growing on beds with SDI.

Figure 3: Grass, Weed, and Root-Knot Nematode Issues in Areas of the Organic Field

Cantaloupes were harvested from 33-foot length samples on each melon bed and the harvest period extended from September 22 to October 5. Because the size of melons harvested ranged from size 6 to 18, yields were normalized on a size 12 using the relative wholesale prices for the San Joaquin Valley, Arizona, and Chicago markets during the harvest period. For example, the price of size 6 melons was 4% higher per half carton or crate than size 12 melons over this period, so the production of size 6 melons was weighted 4% more than size 12 melons. Size 18 melons received 83% of the price of size 12 melons for this harvest period. Thus, size 18 melons harvested were multiplied by .83 to equal the same yield as one crate of size 12 melons. The distribution of melons harvested by size is provided in Table 1. Size 12 was selected for a base since it is essentially the middle size and it was often the most common size harvested.

Table 1: Size Distribution for Four Trials of Conventional and Organic Cantaloupes

Production Method & Variety	Size 6	Size 9J	Size 9	Size 12	Size 15	Size 18	Decay
Conventional							
Direct seeded Olympic Gold (baseline)	0.0%	6.4%	32.7%	22.2%	16.1%	17.8%	4.8%
Olympic Gold grafted on Tetsukabuto	0.2%	13.6%	31.3%	19.6%	13.8%	18.2%	3.2%
Acclaim grafted on StrongTosa	0.0%	5.0%	26.4%	21.9%	24.3%	20.6%	1.8%
Non-grafted transplants of Olympic Gold	0.0%	2.2%	12.4%	20.3%	23.5%	41.6%	0.0%
Organic							
Direct seeded Olympic Gold	0.0%	12.9%	30.2%	21.9%	14.2%	15.1%	5.6%
Olympic Gold grafted on Tetsukabuto	0.3%	9.3%	28.0%	23.7%	16.3%	15.2%	7.2%
Acclaim grafted on StrongTosa	0.0%	11.9%	35.9%	21.8%	13.9%	8.8%	7.7%
Non-grafted transplants of Olympic Gold	0.0%	2.7%	22.8%	30.8%	19.7%	21.1%	2.9%

Economic Results of Field Trials

Table 2 provides a summary of the yield, cost, and break-even price required relative to the baseline of "direct seeded Olympic Gold." Relative values are provided so that comparisons can be made across production methods while keeping the competitive cost level of the cooperating entity confidential. Direct seeded Olympic Gold grown conventionally did not have the highest yielding trial, but this combination did have the lowest production cost and subsequent break-even price. Grafted plants yielded reasonably well compared to direct seeding. Organic production of Olympic Gold grafted on Tetsukabuto had the highest yield, but it also had the highest production cost. Thus, the price needed to cover variable production costs for the grafted conventional and organic Olympic Gold are 4.6 and 3.3 times higher than that required for the baseline of the conventional direct seeded Olympic Gold. Grafted Acclaim cantaloupes had essentially the same production costs as the grafted Olympic Gold, but because the yields were somewhat lower for the Acclaim, the break-even price needed to cover variable production costs for the conventional and organic Acclaim is 5.1 and 4.7 times higher than baseline of the direct seeded Olympic Gold. Because the Acclaim trials were planted 8 days after the grafted Olympic Gold transplants, variations in weather conditions do not make the comparisons equal and results should be treated as preliminary. The non-grafted Olympic Gold and grafted Acclaim transplants were planted only 2 days apart, and their yields are quite similar for both organic and conventional trials. Because their yields are lower than the direct seeded and grafted Olympic Gold, this suggests that weather, insect, and other conditions may not have been as favorable for the later plantings. A new plant virus, Cucurbit Yellow Stunting Disorder Virus (CYSDV), was recently found and identified in Arizona fields in 2006 and 2007 (McGinley and Brown, 2007) and was found in the melon trials. No chemical or biological control currently exists for the virus, which whiteflies can transfer while feeding on different plants. Direct seeded Olympic Gold grown organically has only a 10% higher break-even price than under conventional methods, however, whether these organic melons can continue to be grown in the future with the relatively modest cost increase of 10% to cover variable costs is in question. Populations of the root knot nematode *Meloidogyne incognita* will increase with another direct seeded melon crop so that grafting or another method of nematode control will be required to control this pest. With grafted transplants costing $0.60 per plant versus $0.06 per plant for non-grafted, grafting costs were $3,024 per acre more than transplanting non-grafted plants. An in-row spacing of 14 inches was utilized for all transplants, resulting in a plant population of 5,600 plants per acre. In comparing grafted verses non-grafted transplants for Olympic Gold, the cost of grafting would need to fall below $0.25 and $0.09 per plant for the organic and conventional production methods to be cost effective under the trials conducted.

Table 2: Relative Yield, Cost of Production, and Break-Even Price of Trials.

Production Method & Variety	Relative Yield	Relative Production Cost	Relative Break-Even Price
Conventional			
Direct seeded Olympic Gold (baseline)	100%	100%	100%
Olympic Gold grafted on Tetsukabuto	85.4%	332.9%	390.1%
Acclaim grafted on StrongTosa	76.3%	332.9%	436.2%
Non-grafted transplants of Olympic Gold	79.6%	167.1%	210.0%
Organic			
Direct seeded Olympic Gold	105.8%	116.4%	110.1%
Olympic Gold grafted on Tetsukabuto	124.6%	349.4%	280.3%
Acclaim grafted on StrongTosa	86.3%	349.4%	404.8%
Non-grafted transplants of Olympic Gold	89.0%	183.5%	206.3%

Conclusions

Identifying a successful niche market is very much linked to identifying a production niche for the organization described here. Quality standards in size, firmness, and brix must always be met and monitored for both conventional and organic methods. Anticipating price premiums for organic versus conventional melons during different production windows is a key factor in determining whether organic production should be pursued. Organic acreage is generally small relative to conventional acreage for this operation, and this has allowed them to shift almost all their labor to the organic fields when organic production challenges arise (e.g. seeding transplants by hand, hand weeding, pest control, etc.).

This operation either forward contracts or locks in a price on around 60% of their expected production. Prices are generally set on a slide so that if market prices drop during harvest they don't absorb the full decline, and conversely, don't receive the full benefit if prices increase. Although this operation has received some nice premiums for organic melons in the past, they have also sold many organic melons at conventional prices in order to move sufficient volume when the fruit is ripe.

A key production concern regarding organics for this operation is the ability for insect pests and diseases to quickly spread from small acres of organics to a large investment in nearby commercial melon acreage. That is, the predominant acreage of conventional melons on this operation could be put in jeopardy from a relatively small amount of organic acreage, because insect pests like whitefly will readily move from organic to conventional fields. The ability of whiteflies to spread a virus like CYSDV shows how organic fields, which have very limited effective control options for whiteflies, can adversely impact conventional production.

A natural geography barrier that separates insect pests from organic and conventional fields, but that does not require great distances to move labor and equipment, seems to play a key role in creating a production-market niche for organic melons. While crop rotations are being utilized, a complimentary rotation crop has not been found. Current rotation crops are planted to enhance the subsequent production of higher-valued vegetable crops. While grafting technology shows promise for allowing more high-valued vegetables to be planted year after year, the cost of grafted plants needs to come down in order to be competitive with non-grafted technologies under the field conditions tested. Market niches are continually changing with production niches and experimenting with new production methods is an important component of their viability in the marketplace.

References

Boyhan, G.E., W.T. Kelley, and D.M. Granberry (1999). "Culture." *Cantaloupe and Specialty Melons*. University of Georgia Cooperative Extension Bulletin Number B-1179.

Itagi, T., K. Nakanishi, and S. Nagashima (1990). "Studies on the Production System of the Grafted Nurseries in Fruit Vegetables. I. Methods of Grafting, the Kind of Nursery Tray, Conditions of Acclimatization and the Process During Raising Nurseries in Tomato." *Journal of the Japanese Society for Horticultural Science* 59 (1):294-295.

Kurata, K. (1994). "Cultivation of Grafted Vegetables. II. Development of Grafting Robots in Japan." *HortScience* 29:240-244.

McGinley, S. and J. K. Brown (2007). "New Virus Attacks Melons, Cucumbers and Squash." UA News. Retrieved May 2008 from http://uanews.org/node/13185/.

United States Environmental Protection Agency (2006). "Harmonizing the Clean Air Act and Montreal Protocol Methyl Bromide Phaseouts." Retrieved May 2008 from http://www.epa.gov/ozone/mbr/harmoniz.html.