Organic Strawberry Fields Forever Final Report: Evaluation of Organic Strawberry Transplants for Organic Strawberry Production (2018-2019)



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1. Project Summary

Conventional strawberry nurseries have fumigated nursery soils for decades with methyl bromide, chloropicrin, Telone and other highly toxic, synthetic chemicals. These nurseries have served as the sole source of transplants for both conventional *and* organic strawberry farmers. While many organic growers have expressed dissatisfaction with having to use conventional transplants, they have no other choice because organic transplants have not been commercially available. The "commercial availability clause" contained in the USDA's National Organic Program (NOP) regulations allows organic farmers to legally grow their fruit from conventionally propagated transplants without delineating a timeframe for phasing-out their use. As such, there has been little push from government or market forces to make organic strawberry transplants available to organic farmers who grow public varieties. Research and investments are needed to address these limitations in the organic strawberry industry and to secure a stable, commercial supply of field-tested, public varieties of organic transplants.

Besides the lack of available organic transplants, transitioning away from conventional transplants has been hindered by one important, unresolved field research question: Do organic transplants perform comparably to their tried and true, conventional counterparts on the same farm field? To address this critical question Dr. Lisa J. Bunin, Director of Organic Advocacy (OA), teamed up with Stefanie Bourcier, CEO of Farm Fuel Inc. (FFI) to test the field success of public varieties of organic versus conventional transplants.

In collaboration with five organic strawberry growers, we conducted a field study at five sites in Santa Cruz, San Mateo and Monterey Counties during the 2018/2019 growing season — November through September. Each site was designed as a replicated randomized complete block trial that examined plant growth, disease occurrence and harvestable and non-harvestable yields. Both types of transplants had roughly the same dig date, chill hours and organic production protocols. A group of 20 plants at the center of each plot was marked off with colored coded tape to serve as the data collection "window" for diameter, disease and yield measurements. Field data conclusively demonstrated that organic transplants performed equally if not better than conventional transplants at each field site. We found no significant disease occurrence at any field for either the organic or conventional transplants.

It is our hope that the data compiled from this field trial will provide organic strawberry growers with the reassurances they need to begin transitioning their farms away from conventional transplants. With this latest data now publicly available, we anticipate greater interest from strawberry nurseries in California in producing organic strawberry transplants. Additionally, with the backing of California Certified Organic Farmers (CCOF), organic strawberry farmers will be legally required to grow organic transplants and fully transition to organic as the supply grows to meet the demand.[1] Once organic transplants become the industry standard for organic strawberry growers across the state, approximately 1.3 million pounds annually of the most hazardous pesticides will no longer be released into the environment.[2]

[1] https://www.ccof.org/commercial-availability-organic-strawberry-starts

[2] Bolda, M. UC Cooperative Extension, Strawberry and Caneberry Farm Advisor. Personal Communication. Nov. 29, 2016.

2. Introduction to Topic

All organic and conventional strawberry farmers grow their fruit from transplants. But, until the launch of the *Organic Strawberry Fields Forever* project (OSFF), organic farmers planted only conventional transplants because no organic transplants were commercially available. While their farms and farming methods were organic, organic strawberry farmers used conventional transplants grown in soils fumigated with synthetic, highly toxic and ozone-depleting chemicals. They had no other option. This practice has continued for decades because the Organic Foods Production Act of 1990 (OFPA) permits the use of conventional transplants until an organic supply is available. Recognizing that the lack of field tested, public varieties of organic transplants was preventing organic farmers from relinquishing conventional transplants, Bunin, then Organic Policy Director at Center for Food Safety, created OSFF to catalyze the organic supply and demand.

Beginning with a day-long *Organic Strawberry Summit* in 2013, Bunin organized a series of stakeholder meetings over six years. The meetings covered topics ranging from phytosanitary requirements of organic transplant propagation and movement across county and state lines, to non-toxic methods of soil fumigation and organic certification and regulations. Participants and speakers at each meeting explored what it would take to transition the state's organic strawberry industry. In California alone, approximately 80 million[3] organic transplants are needed to supply all organic strawberry farmers. Public varieties, the subject of this field research, comprise an estimated 36 million[4] of the total organic transplant market in the state.

A significant outgrowth of those meetings was the formation of two new organic strawberry nurseries. First, in 2015 Greenheart Nursery in Arroyo Grande announced that it was producing 7,000 organic plug plants to sell to OSFF growers for field testing. In collaboration with OSFF, FFI collected data from six organic farms in Santa Cruz and Monterey Counties to ascertain whether organic propagation systems can provide organic growers with high quality transplants comparable to their conventional counterparts. While the organic plugs performed equally as well as the bareroot conventional plants in this initial trial, the plug plant propagation method proved to be too costly for the nursery, and it ceased that aspect of its production.

The following year, another regular attendee of OSFF meetings, James Rickert, formed the Innovative Organic Nursery (ION), with Dan Nelson of Plant Sciences, to produce organic transplants and capitalize on the untapped market. Yet even in light of this new source of organic transplants, growers still wanted assurances that the organic plants would perform comparably to the conventional ones before making the switch. To address this need, Bunin and Bourcier again teamed up and received a grant from the Organic Farming Research Foundation (OFRF) to test the field success of public varieties of organic transplants versus conventional. Building on the experience of our previous research, the goal of this field study was to compare organic bareroot transplants with conventionally managed bare root transplants, the type of transplants most often used in organic strawberry production.

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[3] Based on California Strawberry Commission data: California Strawberry Commission. (2019) "California Strawberry 2019 Acreage Survey."

[4] *Ibid*

Research results showed that organic transplants can favorably compete with conventional, as described in detail in the subsequent section.

3. Objectives Statement

The objective of the OSFF field trial was to address organic strawberry farmer concerns about the viability, disease occurrence and yields of organic transplants when compared with conventionally grown transplants in farm fields. To that end, we collected and analyzed field data from organic bareroot transplants and compared them with conventional bareroot transplants at five field sites (see Table 1.) In addition to two farms in Santa Cruz County, we added farms from the neighboring counties of San Mateo and Monterey Counties, which were not included in our original research proposal. The decision to add farms in other counties was based on farmer interest in joining the field trial.

Table 1. Farm, variety, location, planting date and number of plants per treatment.

Farm	Variety	County	Planting Date	No. of Plants per Treatment
Farm 1	Chandler	San Mateo	10/31/18	2000
Farm 2	Albion	Santa Cruz	11/15/18	1600
Farm 3	Albion	San Mateo	11/8/18	1650
Farm 4	Albion	Santa Cruz	11/8/18	2000
Farm 5	Chandler	Monterey	12/1/18	1500

Field Data Collection

Starting in January 2019, the plant diameter of 20 plants within each test plot was measured in centimeters over the widest portion of each plant (Objective 1). Diameter measurements were taken once a month through the end of September. Disease assessment was performed by conducting a wilt score analysis on 20 plants in each test plot (Objective 2). Each plant was visually observed for wilt and then assigned a score between 0 - 4.[5] Scores quantified the prevalence of wilt in each plant, with a 0-score indicating there was no wilt and a 4-score indicating the most severe level of wilt. Wilt scores were taken once a month, beginning in January and concluding at the end of September. Once fruit began to appear in late March to early April, data on yields was collected once a week (twice a week as needed) until the end of harvest season in September (Objective 3). Total plot yield (grams) and individual fruit weight (grams) were measured. The quality of harvested fruit was split into marketable and unmarketable categories based on the individual grower's preexisting fruit quality standards.

[5] Wilhelm, S., J.E. Sagen, and H. Tietz. 1974. Resistance to Verticillium Wilt in Cotton: Sources, Techniques of Identification, Inheritance Trends, and the Resistance Potential of Multiline Cultivars. *Phytopathology, 64*: (924-931).

Yield and fruit weight data were divided into “early yield” and “late yield.” Early yield comprised data collected in early March to May, and late yield comprised data collected from June to the end of harvest season. Regression analysis was conducted using StataIC 16 software.

It is worth noting that this field trial design was modeled after our previous field trial, which we developed in consultation with UC Cooperative Extension (UCCE), using widely accepted field trial protocols. These methods were then adapted to each field site location with the feedback of individual growers. This design and process further optimized the value of the trial by replicating the real growing and planting conditions of each farmer.

Objectives/ Measurable Outcomes

Our field results addressed the following objectives and matched them with the following measurable outcomes:

A - Are organic strawberry bareroot transplants as viable in the field as conventional strawberry bareroot transplants? To determine this, plant diameter measurements were taken once a month from both organic and conventional plants and recorded and compared from the time of establishment in January 2019 through the entire harvest season ending in September 2019.

Outcome: Organic strawberry bare root transplants, with regard to plant diameter, are as viable as conventional bare root strawberry transplants.

B - Do organic strawberry bare root transplants have a different incidence of disease when compared to conventional bare root strawberry transplants? Disease scoring was conducted at each site once a month, comparing organic and conventional plants at the first signs of disease occurrence through harvest.

Outcome: Organic strawberry bare root transplants are not more susceptible to disease, with regard to leaf wilting, as conventional strawberry bare root transplants.

C - Do organic strawberry bare root transplants have the same yields as conventional strawberry bare root transplants? Weekly yields (biweekly as needed) were collected from both the organic and conventional plants and compared through an entire harvest season.

Outcome: Across all farms, organic strawberry bare root transplants have statistically comparable yields to conventional strawberry transplants. Only one farm had early season marketable yields that were higher for conventional transplants. Similarly, one farm had early season unmarketable yields that were higher for conventional transplants compared to organic transplants.

D - What is the adoption rate of organic transplants for the future? OSFF participant farmers were asked to reflect on their experience growing organic transplants in our final meeting and asked whether they will continue growing organic transplants in the future. We also asked representatives from ION how well their transplants were received by the farmers who grew them and to estimate their upcoming year’s sales projections.

Outcome: All OSFF farmers expressed complete satisfaction with organic transplant quality, yield and lack of disease. They also all agreed that they would grow organic transplants again. ION received overwhelmingly positive feedback from the organic farmers who grew their transplants, in addition to

OSFF farmers. Subsequently, ION increased its production from 750,000 to over one million transplants for the 2019/2020 growing season.

4. Educational Approach

Two farmers who participated in our previous field trial joined this one. They are well-known and respected leaders and innovators in the organic farming community. We also reached out to farmers who had attended OSFF meetings and expressed an interest in becoming more involved in the project. OSFF farmers participated in the design of the field site, they chose the location on their farm, and regularly met with those collecting the field data to discuss how the research was progressing. In addition, we held check-in meetings by phone for OSFF farmers to share their experiences, ask questions and ascertain if there were any difficulties that needed addressing. Our technicians troubleshooted on the farm where needed.

Organic strawberry farmers repeatedly stated at OSFF meetings that they would like proof that organic transplants can perform as well as conventional before they were willing to take the risk of planting them. In the view of many, conventional transplants work just fine and they do not want to threaten their economic success. At that same time, farmers understand that relinquishing conventional transplants use on their organic farm is the right thing to do and that it is inevitable.

Field trials conducted by neighbor farmers have been shown to be an effective tool for demonstrating the viability of a given crop, method or input, and for inspiring farmer adoption. We also have found that presenting field trial findings at stakeholder meetings is a good way to disseminate research results to those who need it most. Like OSFF meetings in the past, we held this one at UC Cooperative Extension in Watsonville because farmers are familiar with that location and it is easily accessible. The material presented provided concrete evidence to help growers and others in making decisions regarding their future production and use of organic transplants.

5. Project Results

Field Data, Statistical analysis:

Statistical analysis was conducted using a regression analysis to regress total marketable and unmarketable yield, average marketable fruit weight, plant canopy diameter, and wilt scores. This was done for both treatments (organic and conventional), and both varieties (Chandler and Albion), and on each farm site. Categorical variables were appropriately coded for and standard errors were clustered at the block level.

Looking at the average marketable yields for the whole season across all farms, there was not a statistically significant difference between organic transplants compared to conventional transplants, with a p-value of .525 (Figure 1). Similarly, when marketable yields were divided into early yield and late yield, there were still no statistically significant differences between organic and conventional transplants, with a p-value of .771 and .631 respectively (Figure 2). One thing to note is that when looking at the individual farm data, there were statistically significant higher early season marketable yields for the conventional transplants as compared to organic at Farm 2, with a p-value of .073 (Figure 3).

Figure 1. Marketable strawberry yield (grams) for all farms between March and September 2019.

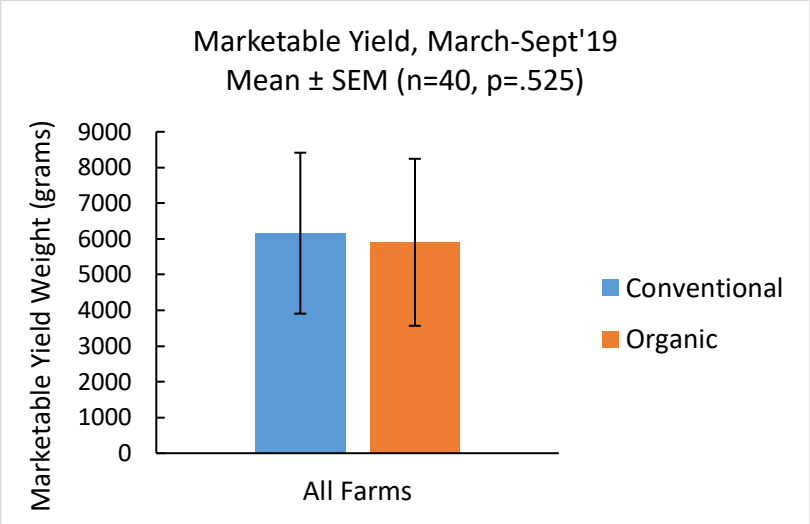


Figure 2. Early season (a) and late season (b) marketable strawberry yield (grams) for all farms.

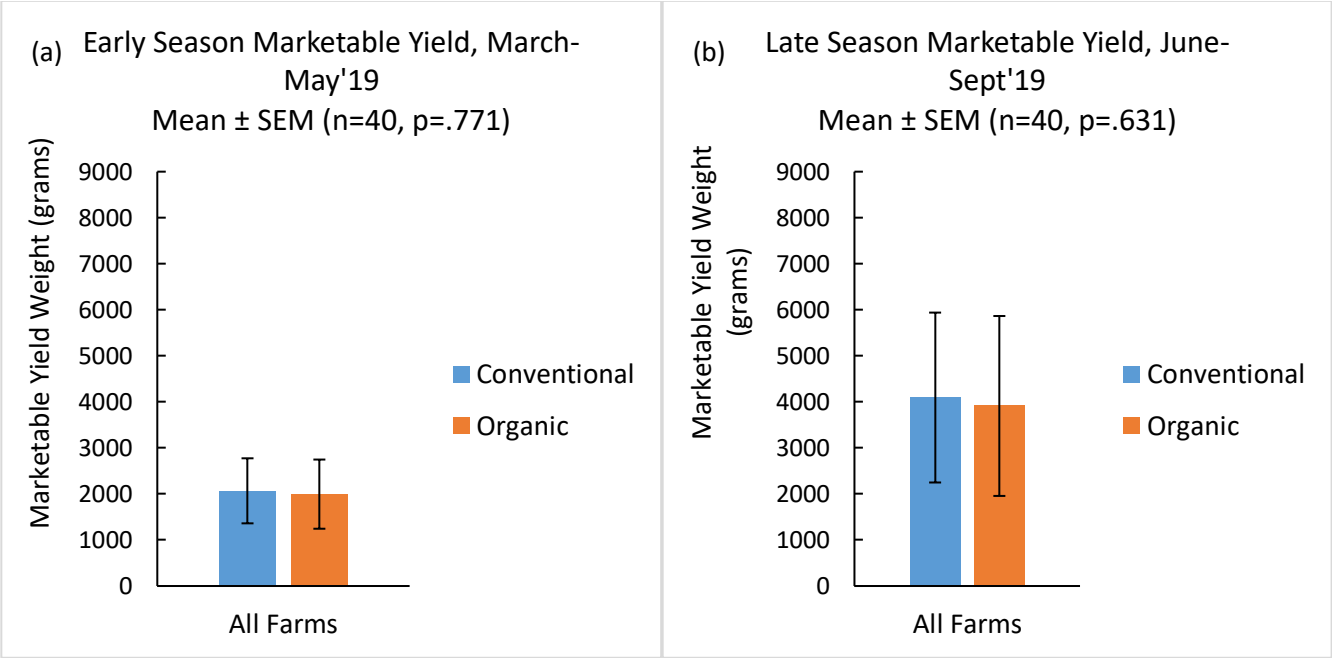


Figure 3. Early season marketable strawberry yields (grams) for each individual farm.

With regard to average unmarketable yields across all farms for the whole season, conventional transplants had statistically significant more unmarketable yields than organic transplants, with a p-value of .09 (Figure 4). However, when unmarketable yield data were split into early and late season yields, this statistically significant difference disappeared, with a p-value of .229 and .388 respectively

(Figure 5). Looking at the individual farms, however, Farm 3 had statistically significant higher early season unmarketable yields for the conventional transplants as compared to organic, with a p-value of .011 (Figure 6).

Figure 4. Unmarketable strawberry yield (grams) for all farms between March and September 2019.

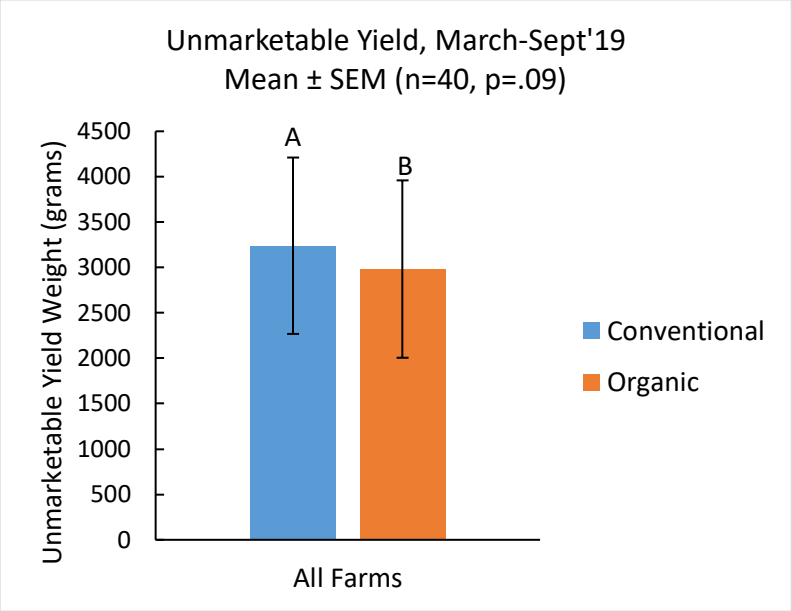


Figure 5. Early season (a) and late season (b) unmarketable strawberry yield (grams) for all farms.

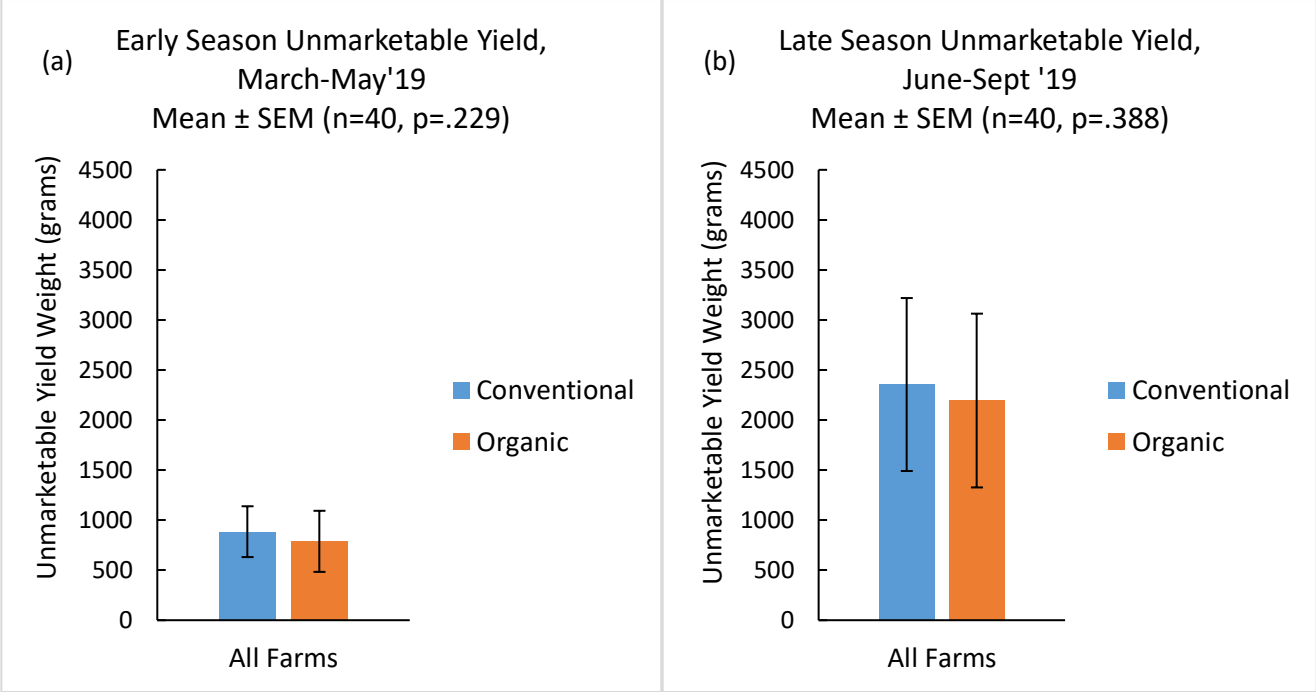
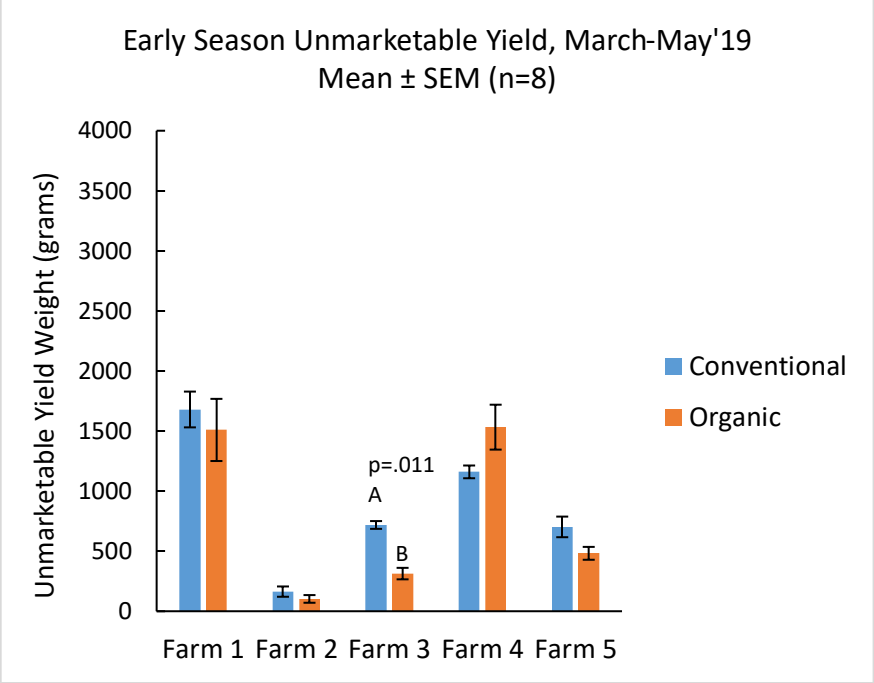


Figure 6. Early season unmarketable strawberry yields (grams) for each individual farm.



Average marketable fruit weight (grams/fruit) for conventional and organic transplants were not statistically significantly different from one another across all farms and all points in the harvest season (Figures 7 and 8). Similarly, for plant canopy diameter and disease wilt scores averaged across all farms, there were no statistically significant differences between organic and conventional transplants (Figure 9 and 10).

Figure 7. Marketable fruit weight (grams) for each individual farm.

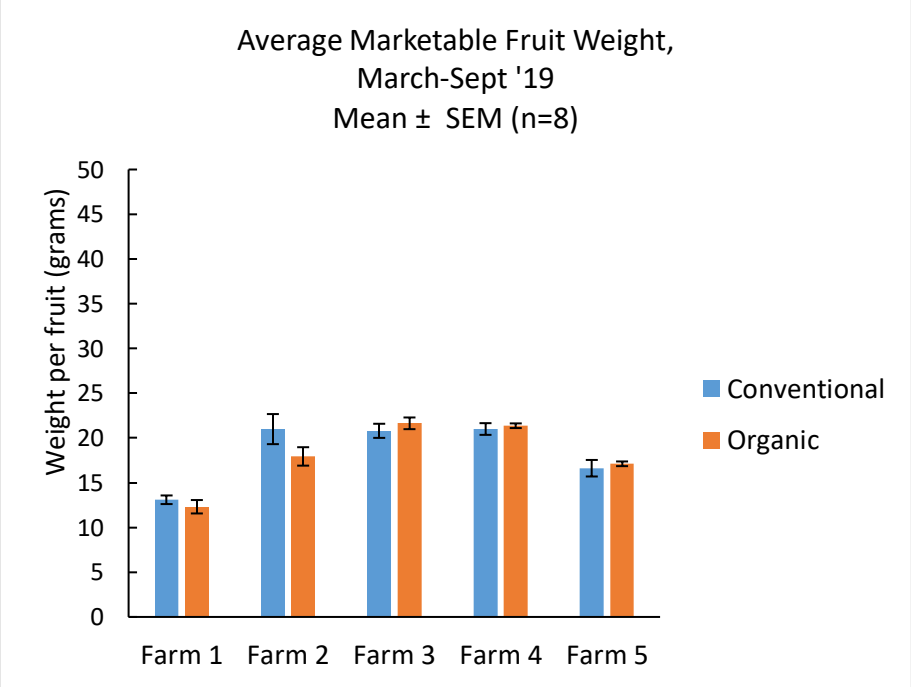


Figure 8. Early season (a) and late season (b) marketable fruit weight (grams).

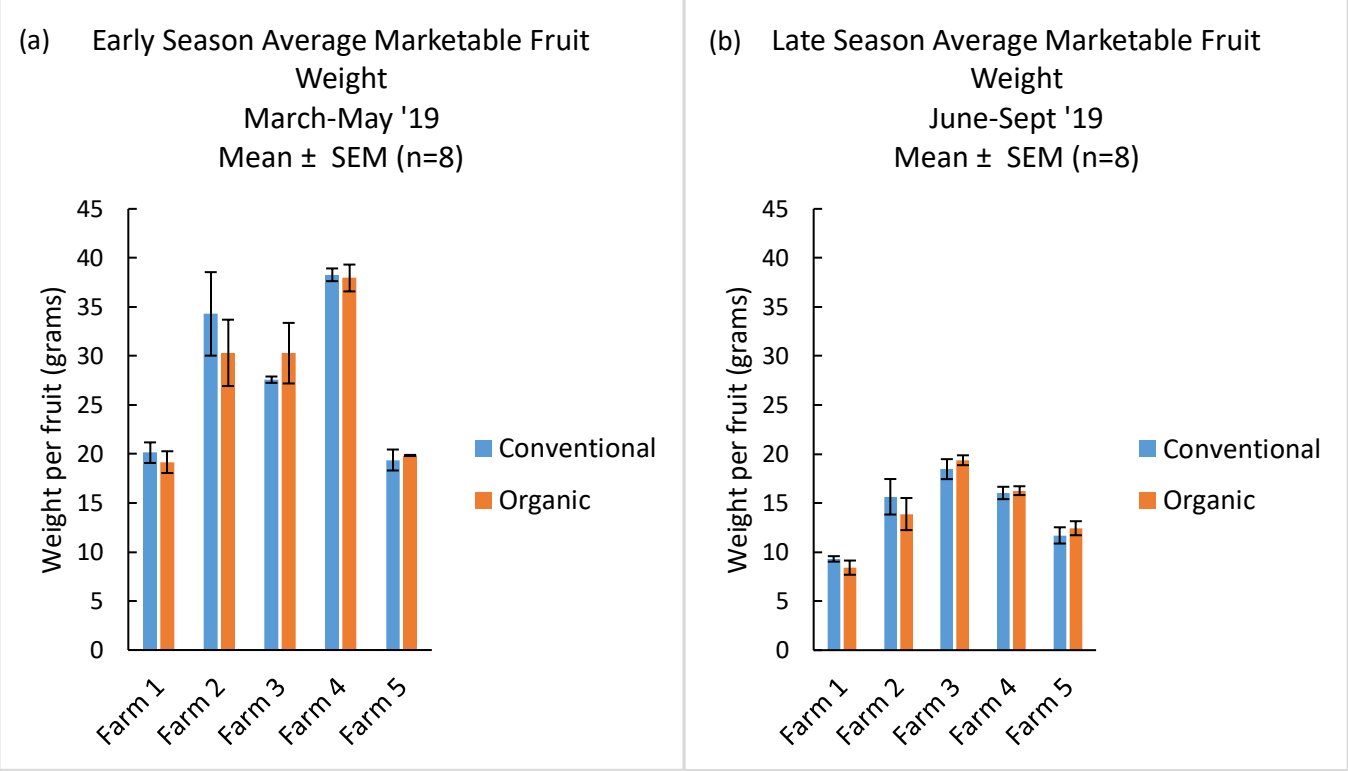


Figure 9. Average plant canopy diameter across all farms.

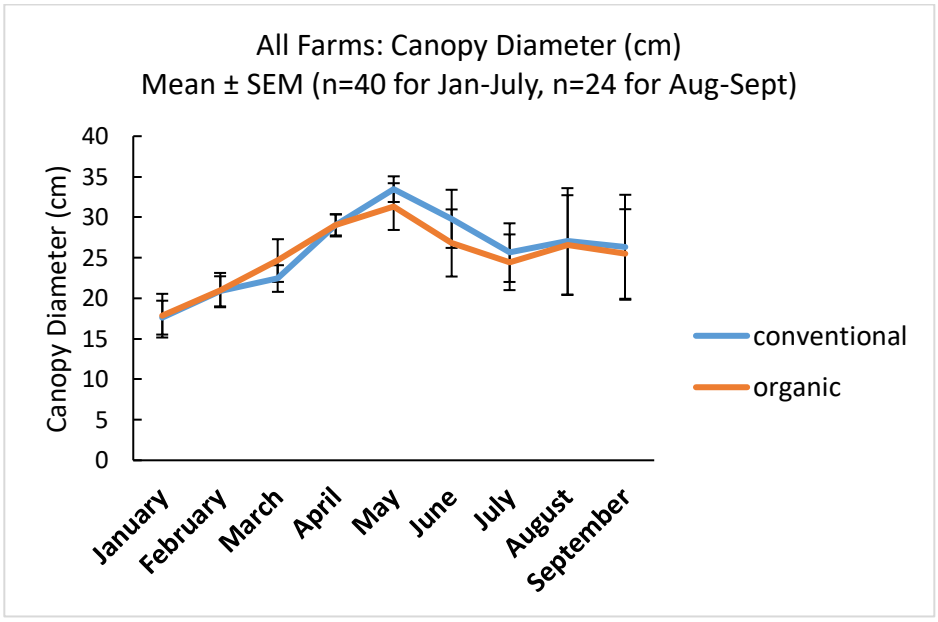
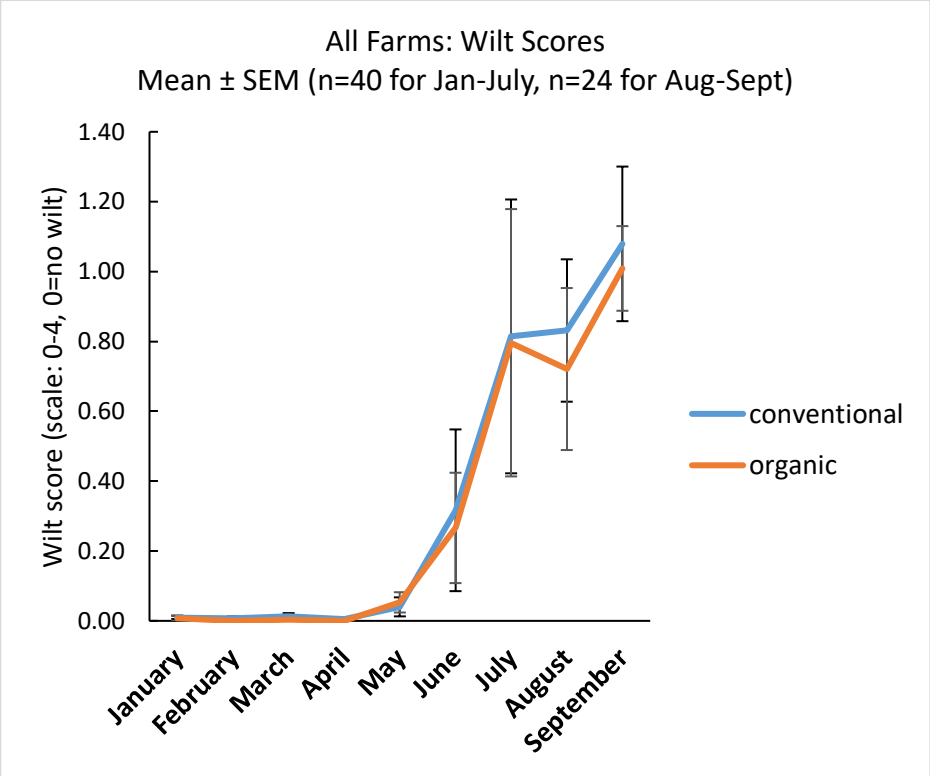


Figure 10. Average wilt score across all farms
(0-score equals no wilt; 4-score equals 75%-100% of leaves wilted).



Grower and Nursery Feedback

We interviewed OSFF growers after the final harvest about the plant quality, yield, disease and overall production performance. This was done in a group setting and on an individual basis. We chose to use verbal, personal interviews instead of a written survey because our experience has shown that growers tend to be more responsive to verbal communication and adverse to surveys. OSFF farmers unanimously and unreservedly agreed that they were satisfied with the performance of the organic transplants in comparison to the conventionally grown transplants. All field trial participants stated that they would use organic transplants again the following season, without reservation. The organic nursery participating in the trial, ION, reported in a follow-up interview that, based upon market demand and the positive feedback received from this trial, the company had increased its production of public varieties to over one million for the 2019/2020 season.

6. Conclusions and Discussion

OSFF's field trial research has conclusively demonstrated that organic transplants perform comparable to conventional transplants in farm fields on the Central Coast of California with respect to plant growth, disease occurrence, and harvestable and non-harvestable yields. The data and analysis presented in this report, and at our organic strawberry stakeholder meeting at UC Cooperative Extension in Watsonville, are intended to provide organic strawberry growers with the confidence they need to begin their

transition to organic transplants. It is also expected that our field data results will pique the interest of strawberry nurseries to begin growing organic transplants to meet the anticipated increase in demand.

In terms of project hurdles, the primary one was the delay of our field trial for one year, due to the unavailability of organic strawberry starts from the nursery. For this reason, OFRF graciously allowed us to conduct our research the following year. This situation reflects the real concern that the organic strawberry stock is limited by location and providers and that multiple organic strawberry nurseries are needed to supply farmers with a stable source of organic starts.

Once the project had begun, challenges faced in the field were not uncharacteristic of field trials in the Central Coast of California. Heavy rain and mud were consequences of a late spring rainy season, which made data collection challenging at times. Issues with communication between our field technicians and the growers' pick crew on-site were not atypical. With field sites stretched over three counties, driving time and flexibility were sometimes an issue for field technicians, but they were overcome.

In terms of future research, a subsequent study of the same public varieties at the same farms would also be useful to corroborate our research results. Since this study trialed only two public varieties of organic transplants, Albion and Chandler, organic strawberry growers would benefit from field tests of other public varieties. Trials are also needed in other regions where strawberries are grown and where different microclimates and growing conditions are present.

This type of project aimed at facilitating a major change within the organic strawberry industry would undoubtedly benefit from multiple years of research and funding. As such, an institutional home at a college or university is sorely needed where year-round resources and labor can be devoted to support the growth and development of organic strawberry transplant research and development.

Although our study tested organic transplants under organic growing conditions, the cultivars used have been propagated in and for conventional agricultural systems. In fact, most if not all of the university-based research on public varieties of strawberry cultivars in California is exclusively focused on the development of conventional cultivars. On occasion, these conventional public varieties are tested on organic farms, but they are still not bred for organic conditions. The organic strawberry industry would hugely benefit from university-bred, public cultivars of organic strawberry transplants specifically designed to grow in organic production systems.

7. Outreach

The intent of our research was to conduct field research and present our results to the wider organic strawberry stakeholder community. We announced the receipt of our grant with a press release to

inform organic the strawberry industry and general public about our organic strawberry transplant field test on farm fields in the region.[6]

Bunin made several presentations at Central Coast CCOF Chapter meetings about OSFF and our field trials. She also organized two meetings with CCOF administrators and OSFF farmers to explore the ways in which CCOF could help facilitate farmer transition to organic transplants.

On 25 November 2019, OSFF held the latest in a series of two-hour meetings organized over the past six years to discuss technical and regulatory impediments and opportunities for transitioning the organic strawberry industry to use organic transplants. We held our meeting at the UC Cooperative Extension office in Watsonville because it offers a central location and easy access for meeting participants. Announcements of the meeting were sent to OSFF's list of more than 100 stakeholders including farmers, nurseries, researchers, public interest organizations, organic input suppliers, and organic certifiers. They were also sent to FFI's and UC Cooperative Extension lists and posted on CCOF's website.

At the meeting Bunin, from Organic Advocacy, and Fernando Garcia, from Farm Fuel, gave PowerPoint presentations about the evolution of OSFF, our field trial findings and how our data provided the evidence that organic strawberry growers were asking for to feel confident about transitioning to organic transplants. The presentations also provided information useful to nurseries who may be considering producing organic transplants, given the impending increase in demand. Maria Barajas, from CCOF, discussed the certifier's expectations of organic growers now that organic transplants are available. James Rickert, from ION, discussed the past year's success and the nursery's plans for the future. Emily Musgrave, from Driscoll's, discussed the multiple technological and regulatory challenges the company faced growing proprietary organic transplants and moving them across state lines.

OSFF has produced a two page summary of the project in Spanish and English and it is featured on Bunin's website: www.organicadvocacy.org. We also created a poster board display, with photographs and a description of the OSFF field trial, which was exhibited at Farm Fuel's Sustainable Strawberry meeting. Bunin wrote an article about our OSFF research for PCC Natural Markets' publication, *Sound Consumer*, for its summer edition. The natural food market has 13 stores in Washington and 70,000 members. *Edible Monterey* magazine is interviewing Bunin about the field trial for its summer issue.

Farmer participants in the OSFF field trial often host farm tours where they routinely discuss our organic strawberry transplant research. In January 2020, one of our OSFF farms, JSM Organics, was a stop on EcoFarm's annual farm tour where Javier Zamora explained his participation in our field trial and his satisfaction with growing strawberries from organic transplants. At the annual EcoFarm conference, Zamora also moderated a workshop in Spanish where he discussed his experience growing organic transplants, the success of the field trial, and encouraged others to trial organic transplants on their farms.

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6 Staff. (2017) "Pioneer Organic farmers to field test new organic strawberry starts," *The Pajaronian*, May 18. **http://organicadvocacy.org/docs/OFRF_Grant_PR_5_1_2017.pdf**

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Appendix

OSFF Project Photos

Fernando from Farm Fuel shows how we mapped the field trials. The area taped off in blue designates the organic transplants and the orange tapped-off area designates the conventional transplants.

Tom Broz at the organic strawberry field trial site at his Live Earth farm.

Flor Revolorio at the organic strawberry field trial site at Pie Ranch.

Jim Cochran, field trial participant from Swanton Berry Farm, presenting at OSFF meeting.

First harvest of Swanton Berry Farm's organic strawberries from organic starts.

OSFF project display at Farm Fuel Inc. berry meeting at UC Cooperative Extension in Watsonville.