Ecosystem Enhanced Screenhouse Cucumber Production

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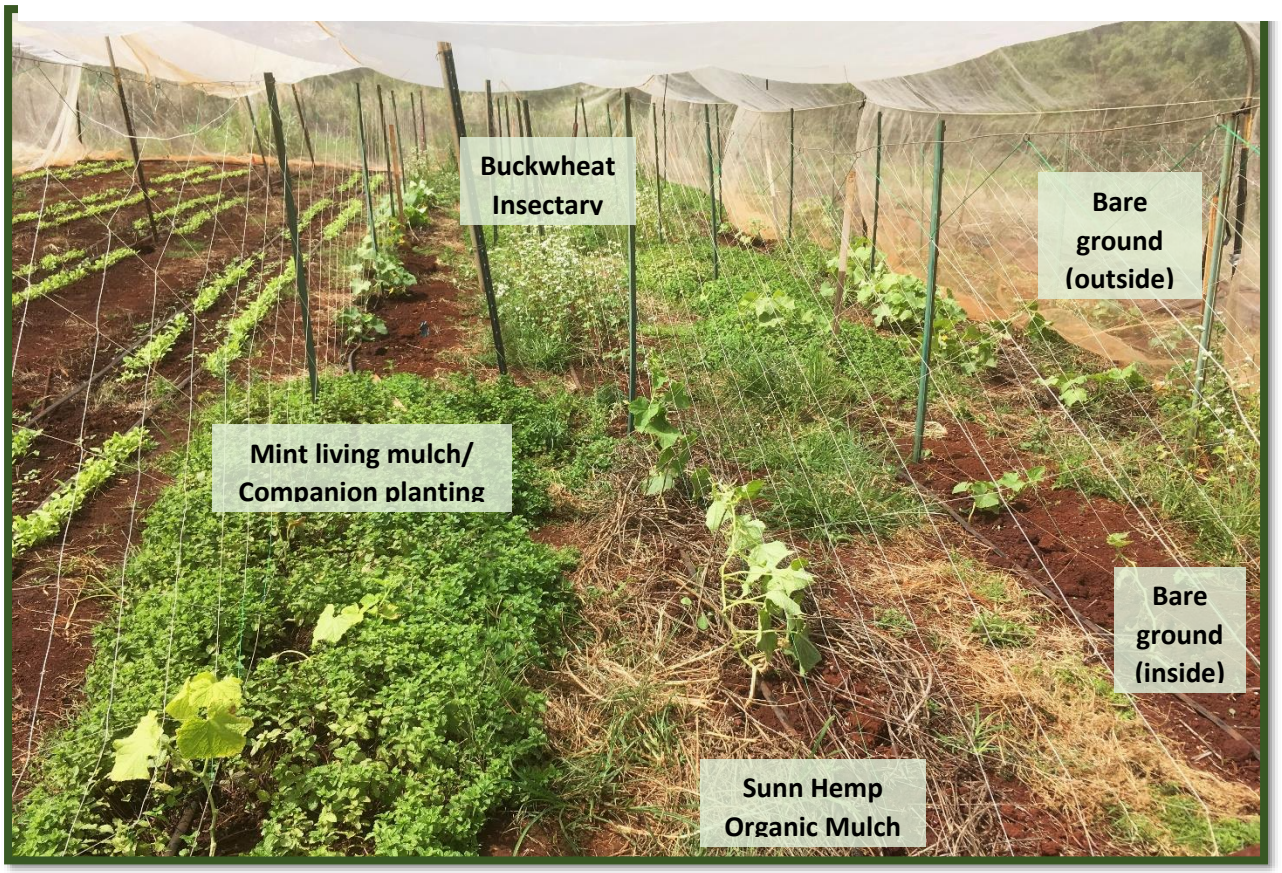


Fig. 1. A screenhouse field trial was conducted to compare cucumber grown on 1) sunn hemp organic mulch, 2) mint living mulch, 3) bare ground inside the screenhouse and 4) bare ground outside of the screenhouse.

Screenhouse production for cucurbit crops is gaining popularity due to its ability to protect cucurbits from larger insect pests such as pickleworms and melon flies. However, farmers continue to be challenged by smaller insect pests such as aphids, white flies, and thrips; plant-parasitic nematodes and weeds inside the screenhouse. This is because as the 17-mesh screen is a barrier of larger insect pests, it also becomes a barrier for larger predators of small insect pests. An initial attempt to design a retractable wall screenhouse that opens one side early in the day to accommodate beneficial insects and closes later in the afternoon to block out nocturnal insect pests failed to control insect pests effectively due to wide range of insect behavior coexisting in a cucurbit agroecosystem in Hawaii. Many cucurbit growers in Hawaii raised concerns about outbreaks of insect pest such as aphids, whiteflies, thrips or mites inside their 17-mesh screenhouse. This project aims to design an "***Ecosystem enhanced screenhouse for cucumber production***" through planting of insectary plants (buckwheat), companion ground cover, and cut-and-carry sunn hemp clippings as surface organic mulch in a no-till farming system that can eventually lead to improved ecosystem health inside a screenhouse.

***ECOSYSTEM MANAGEMENT EXPERIMENT WITH PARTHENOCARPIC CUCUMBER VARIETIES*:** Two field trials were conducted at the University of Hawaii's Poamoho Experiment Station, Waialua, HI. Trial I was conducted from December 2018 to February 2019, and Trial II from March to June, 2019. Prior to

initiation of these trials, sunn hemp cover crop was planted for two months to serve as a nematode suppressive cover crop. Parthenocarpic 'Diva' and 'GVS 603' cucumber varieties were planted in Trial I and Trial II, respectively. After initial soil incorporation of sunn hemp, all field plots were managed by no-till. Four cucumber planting treatments installed were: 1) Sunn hemp strips planted outside of the screenhouse were cut and carried inside and used as surface organic mulch; 2) mint as ground cover/companion planting with cucumber; 3) bare ground inside the screenhouse, and 4) bare ground outside the screenhouse but planted next to a strip of sunn hemp (Fig. 1). Buckwheat strips were randomly planted inside the screenhouse. Various parameters were monitored in these field trials.

Results

Majority or all of cucumber fruits harvested from outside of the screenhouse were unmarketable due to pickleworms or fruit flies damage (Fig. 2). While no significant difference was observed in Trial I among treatments inside the screenhouse, sunn hemp treatment yielded significantly higher than all the other treatments in Trial II. Well established mint ground cover in Trial II had resulted in competition with cucumber growth, and mint also affected weeding efforts (Fig. 3). Thus, it is not recommended to grow mint as companion plants with cucumber. Screenhouse provided additional benefits of reducing weed seeds introduction from outside. Non-the-less, planting mint as ground cover or mulching the soil with sunn hemp significantly improved water infiltration rate into the soil, and can lead to better water conservation in this no-till farming cucumber.

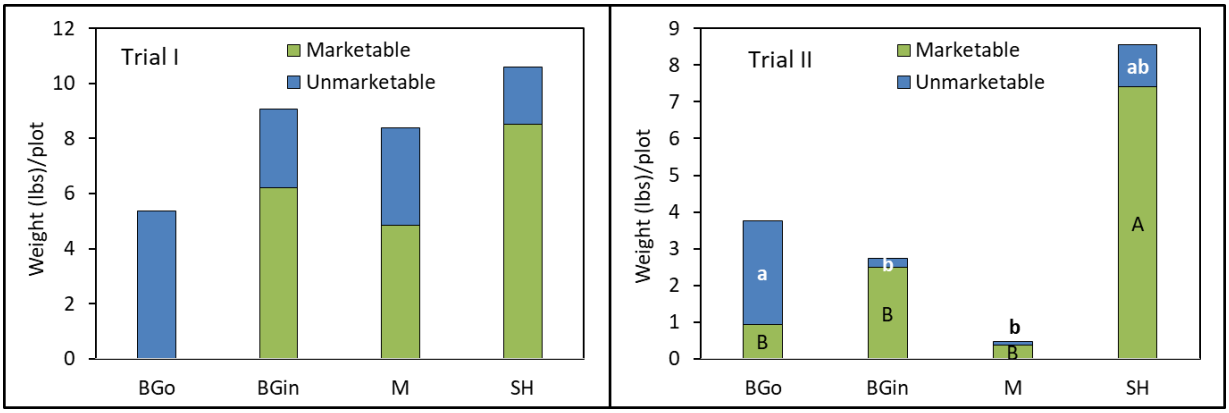


Fig. 2. Cucumber yield in 1) bare ground outside of screenhouse (BGo), 2) bareground inside of screenhouse (BGin), 3) mint living mulch plot (M), and 4) sunn hemp as organic mulch (SH) in Trial I and Trial II. Columns followed by same letters indicated significant difference in marketable yield ($P \leq 0.05$).

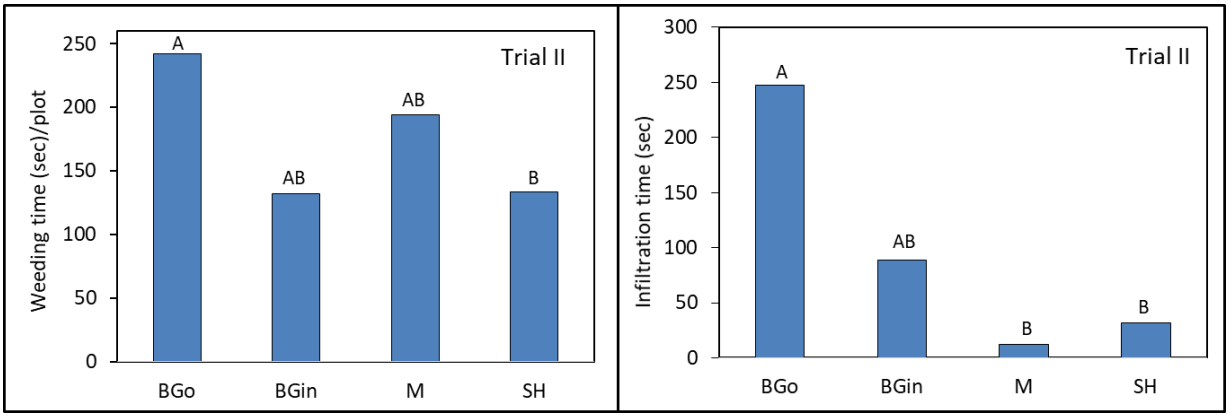


Fig. 3. Manual weed removal 1 month after cucumber planting was lower in the screenhouse vs outside. Weeding in mint is more time consuming than SH. Water infiltration rate was faster in SH and M plots.

Buckwheat flowers provide easy to access pollen and nectar for hoverflies, a beneficial insect where the larval stage can feed on aphids.

Though more beneficial insects were found outside of the screenhouse, insect pests such as whiteflies and thrips were not higher in abundance inside this "Ecosystem Enhanced Screenhouse" (Fig. 4 & 5). Buckwheat and cut and carry of sunn hemp mulch might have provided certain level of favorable habitats to maintain the population of predators or parasitoids.

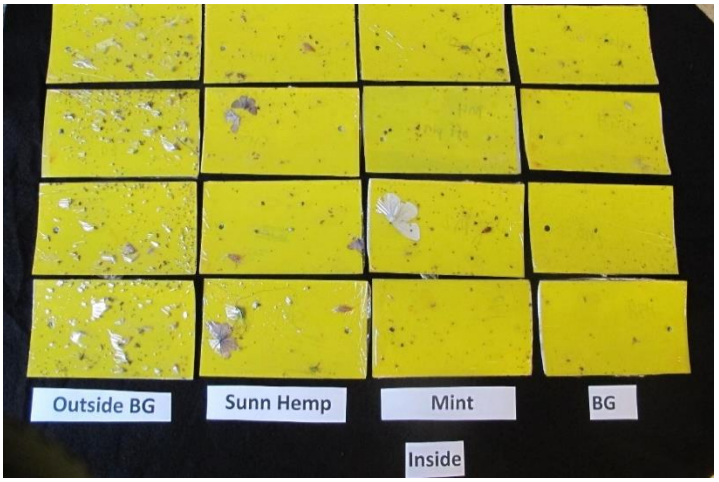


Fig. 4. Yellow sticky traps were placed in the center of each plot next to cucumber plants to monitor arthropods visit.

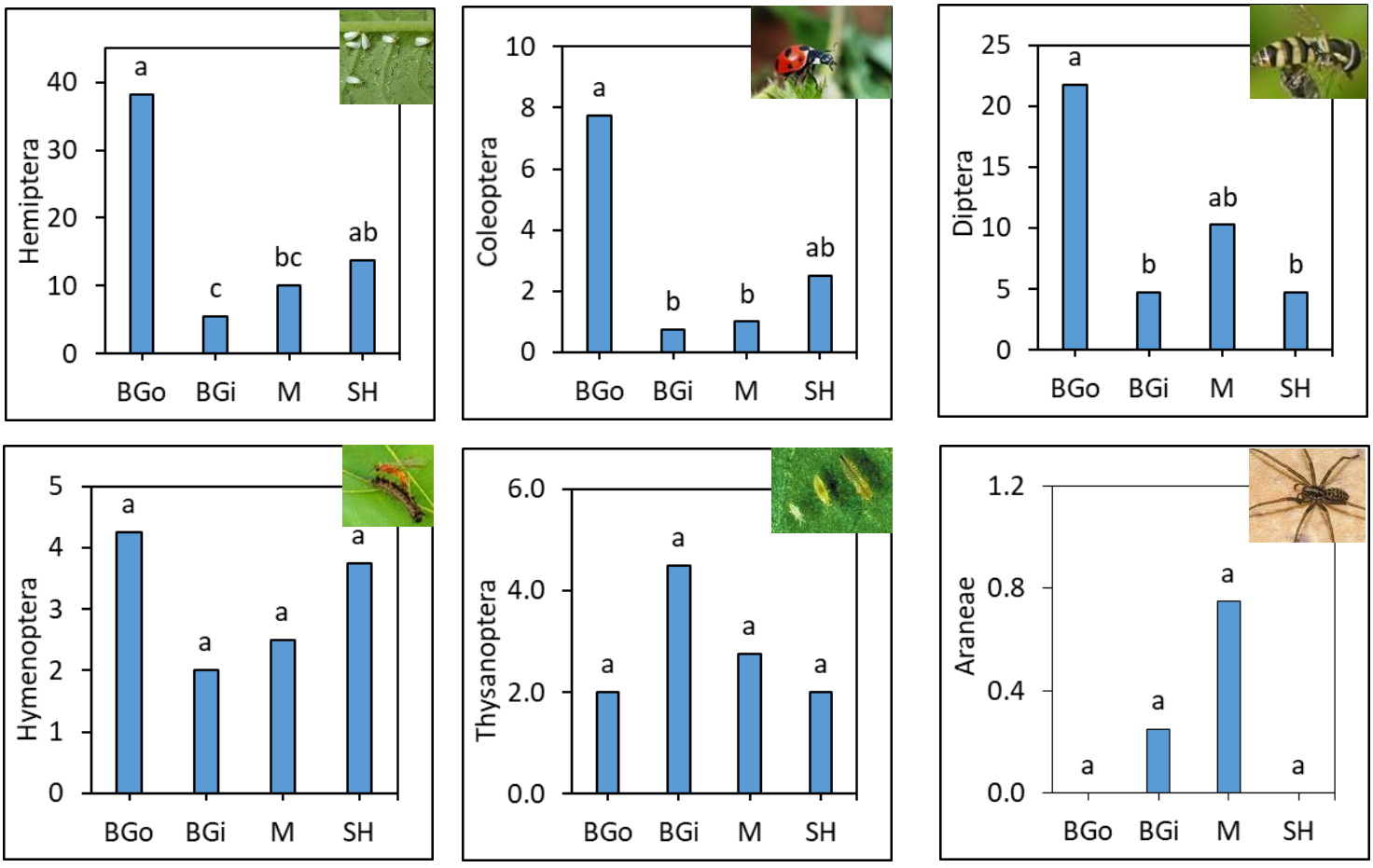


Fig. 5. Beneficial arthropods in the orders of Coleoptera, Diptera, Hymenoptera, and Araneae as well as pest arthropods in the orders of Hemiptera and Thysanoptera monitored on yellow sticky traps placed in the center of each cucumber plot towards the end of Trial II (BG=bare ground inside or outside, M=mint ground cover, SH=sunn hemp mulch).

Specialty Cucumber Variety Experiment: **Parthenocarpic** means that the plant can set fruit without pollination. Since pollinators are not required in this case, parthenocarpic is a desirable characteristic for cucumbers grown in a protected screenhouse system. In a cucumber variety trial conducted in 17-mesh screenhouse at CTAHR (Sugano et al., 2014), Persian cucumber yielded an average of 3 lb/plant. **Jawell, Unistars, Alexander and GVA** hybrids are among the high yielding and good quality parthenocarpic cucumbers (Fig. 6). In the 2014 trial, cucumber was fertilized at 160 lb of N/acre. Using the best treatment in our "Ecosystem enhanced cucurbit screenhouse system" (i.e. SH mulch), 'GVS 603' yielded 4.2 lb/plant and 'Diva' yielded 3.5 lb/plant at a reduced N fertilizer rate (66 lb N/acre). This is another incentive to practice organic mulching with green manure such as sunn hemp inside the screenhouse.

A screenhouse trial was conducted September-November, 2019 to examine if non-parthenocarpic cucumber varieties can yield well in the "Ecosystem enhanced screenhouse system (EESH)" as EESH might provide appropriate habitats for alternative pollinators. The varieties tested included 'Mexican Sour Gherkin' and 'Striped Armenian' (Jonny's Seeds, Winslow, Maine); 'Sweet Slice' and 'Silver Slicer' (Harris Seeds, Rochester, NY). 'Diva' was included as a parthenocarpic reference. All varieties were managed in a 17-mesh screenhouse planted with strips of buckwheat and fertilized with Sustane® fertilizer 8-2-4 (Sustane Natural Inc, Cannon Falls, MN) at 66 lb N/acre.

Sweet-Slice

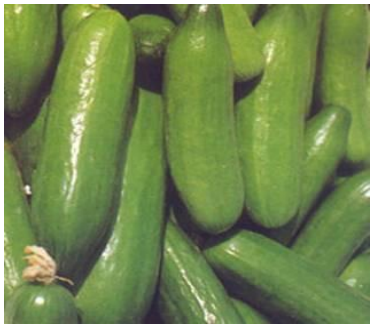
Striped Armenian

Mexican Sour Gherkin

Silver Slicer

Diva

GVS 'Nariman'



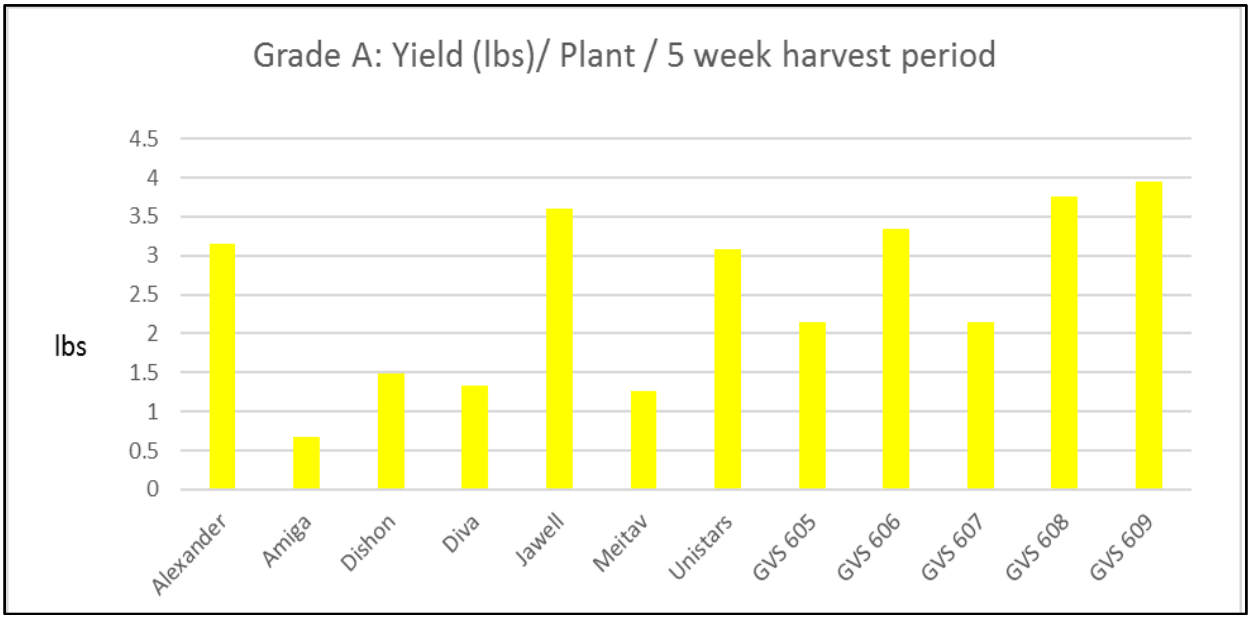


Fig. 6. Twelve varieties of parthenocarpic cucumber yield per plant following 5 week of harvest inside a 17-mesh screenhouse at Poamoho, HI in 2014 (Sugano, 2014).

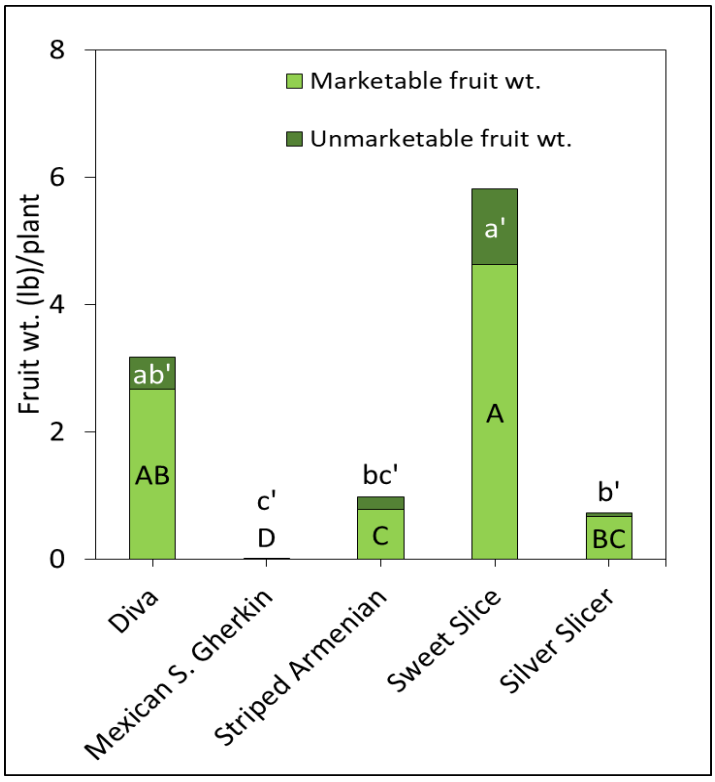


Fig. 7. Yield of five cucumber varieties for 8 weeks of weekly harvest inside a 17-mesh "Ecosystem Enhanced Screen-house" at Poamoho, HI in 2019 (n=4).

Among the four non-parthenocarpic varieties tested in this EESH field trial, only 'Sweet Slice' cucumber yielded comparable or 1.7 times higher than the parthenocarpic 'Diva' (Fig. 7). This might not mean the other varieties are not suitable to grow in the EESH condition. They might be lower yielding varieties than 'Diva' in general. Only 'Mexican Sour Gherkin' did not set fruit fully in the screenhouse. Both 'Striped Armenian' and 'Silver Slicer' did produce marketable fruits (Fig. 8) but with lower fruit set.

Fig. 8. 'Sweet Slice' cucumber set fruits early with high yield.

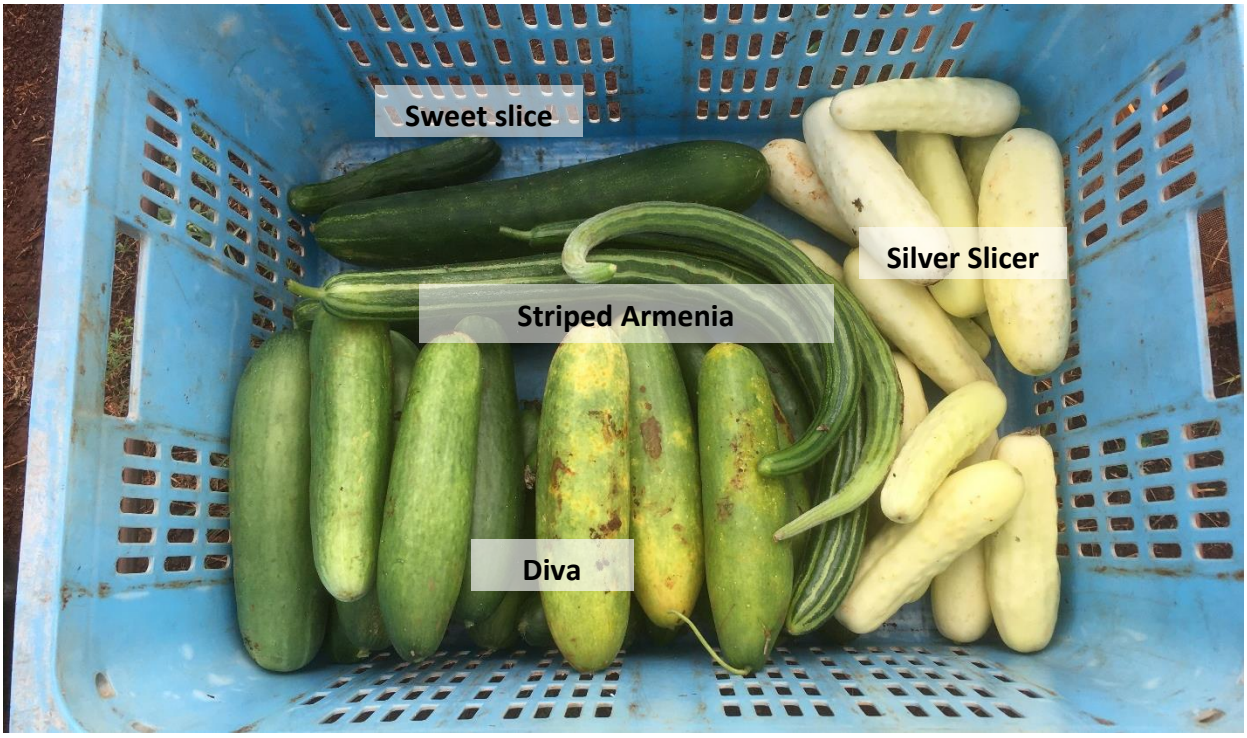


Fig. 8. Fruit set of 'Diva', 'Sweet Slice' 'Striped Armenian' and 'Silver Slicer' cucumbers.

Some fruit flies got in the screenhouse and resulted in some unmarketable fruits towards the end of the crop (Fig. 7), None-the-less, at a yield of 4.62 lb/plant for 'Sweet Slice' cucumber in an EESH, this would be extrapolated to 138.6 lb of fruits in a 30×14 ft2 screenhouse based on 3 ft spacing between plants and 4 ft spacing between rows. Using the DIY screenhouse designed previously published by our team, a 30×14 ft2 hoop-shape screenhouse cost $512/house (Wang et al., 2017). At $3.69-$4.99 per lb of cucumber market price, this 'Sweet Slice' cucumber harvest would yield $511 - $691 per house. There is other cost associated with EESH cucumber production which is not being analyzed here. None-the-less, growing non-parthenocarpic cucumber can lead to profitable production over time through this EESH practice. For more information related to this project, please visit
https://drive.google.com/file/d/1JBA_3iY3W4lIg4YBmf8CJaJHkFA6fC-q/view?usp=sharing.

Reference

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Wang, K.-H., J. Sugano, S. Fukuda, S. Ching, J. Kam, J. Uyeda, and D. Meyer. 2017. DIY Screenhouse for insect management in the Tropics: Part II Hoop Houses. Hānai'Ai Newsletter 28: Dec, Jan, Feb 2017.

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