

INSIDE THE GREENHOUSE: GEOTHERMAL ENERGY AND SPIDER MITE PRODUCTION

Linda Riley, Oregon Institute of Technology, Klamath Falls, Oregon

INTRODUCTION

Variety is intrinsic to Tracey Liskey's agricultural operations and the use of geothermal water at Liskey Farms. In past decades, the 190–200°F water was used to soften cull potatoes which were fed to cattle. The softening, Tracey explains, “eliminated the choke problem.” Currently, the water is used for space heating, aquaculture pond heating, biodiesel production and greenhouse heating. The greenhouses, divided into two areas, are leased to two different companies; Fresh Green Organics, a community supported agriculture (CSA) organization that grows a plethora of produce, and Biotactics, a bio-controls company that raises spider mites and predator mites. This mite operation, (I have nick-named it “entomoculture”), consists of harvesting the eggs of the spider mites, feeding the eggs to predator mites and then using predator mites in place of pesticides. Only the spider mites are raised at Liskey farms – just another crop to Tracey. With a compendious manner, Tracey simply states, “we’re the hay to the feedlot.”

THE MITES:

Biotactics leases 11 greenhouses (a total of nearly an acre) from Liskey Farms, one of which is used to germinate lima beans (food for the mites). The remaining 10 (each 30 x 120 feet) are used for the production of the spider mites. Spider mites are members of the *Acari* (mite) family Tetranychidae, which includes about 1600 species. The spider mite raised by Biotactics, *Tetranychus urticae* (the ‘glasshouse red spider mite’ or ‘two-spotted spider mite’) is the most common of the family, particularly in tropical and warm temperate zones and in greenhouses. Spider mites generally live on the under sides of leaves of plants and use modified mouthparts to pierce plant cells. The destruction of the chloroplasts in the leaves leads to a decrease in photosynthesis and eventually plant death. Spider mites are known to feed on several hundred species of plants. They are less than 1mm in size, lay small, spherical eggs and may spin silk webbing to help protect their colonies from predators, the behavior that leads to the ‘spider’ part of their common name (Figure 1). In optimal conditions, spider mites can hatch in as little as 3 days and become sexually mature in as little as 5 days. One female can lay up to 20 eggs per day and can live for 2 to 4 weeks. A single mature female can spawn a population of a million mites in a month or less. Because of this accelerated reproductive rate, spider mite populations can quickly adapt and become resistant to pesticides. According to Skip Maltby, owner of Biotactics, spider mite populations are now completely resistant to the common insecticide “Sevin.”

At the Liskey Farm/Biotactics operation, a patented process is used to wash the spider mites and their eggs off the lima bean leaves into small canisters. These canisters are then shipped via one-day UPS to the Biotactics labs in Romoland, California (east of Los Angeles) where they are fed to a variety

of predator mites; each variety is raised in a climate controlled environment that simulates its native region. Biotactics currently sells eight different species of predator mites including *Neoseiulus Fallacies*, a predator mite native to the northern California/southern Oregon region. This practice of using predator mites, or bio-controls, in place of pesticides is called Augmentative Biological Control (ABC). Different predator mites are used for different applications, some are most effective in greenhouses, some on low growing plants, some for avocados, others for strawberries, and some for fruit trees, grapes and other deciduous trees. Biotactics explains on their website that the beneficial predator mites feed only on spider mites and do not bite or harm humans or animals. Once they have consumed the plant pest spider mites, they leave in search of more spider mites elsewhere. Strawberry growers are Biotactics’ largest client; a recent contract with a strawberry farmer totaled approximately \$1 million.



Figure 1. A colony web of spider mites.

As Tracey led me from greenhouse to greenhouse to show me the different levels of mite population growth, I couldn't help but wonder how the mites were contained in the greenhouse – what measures had to be taken to ensure that they didn't infest other areas? “Oh, mites are everywhere,” Tracey shrugged casually. “We keep the perimeter of the greenhouses weed-free, and occasionally an insecticide is used to clean out a greenhouse before new plants and mite populations are brought in.” “Generally,” he explained, “the mites stay in the greenhouse – they've got all the food they need, and the 90 °F (32.2°C) climate is ideal.” Indeed, I thought. On the chilly day I'd chosen to visit, I thought I'd much rather be in the gentle 90 degrees than the blustery 45 degrees outside. Tracey and other Liskey Farm employees also take precautions when touring people through the CSA greenhouses and the Biotactics greenhouses. Tours always finish with Biotactics to ensure people don't track unwanted mites into the CSA greenhouses.

THE BEANS:

Of the 11 greenhouses rented by Biotactics, one is used for the sole purpose of sprouting lima beans which become food for the spider mites. Lima beans grow quickly in the 90°F heat – approximately three inches in two days, and provide a large leaf area (a lot of chloroplasts) for the mites to munch (Figure 2 and 3). The beans do not require any fertilizer for the amount of time they are grown, and are irrigated using a drip irrigation system. When it is time to harvest the spider mite eggs from one greenhouse, two thirds of the mite-infested plants are harvested and the remaining one-third is used to inoculate a new batch of bean plants. The harvest rotates between the houses; all ten houses are harvested in a two week period.

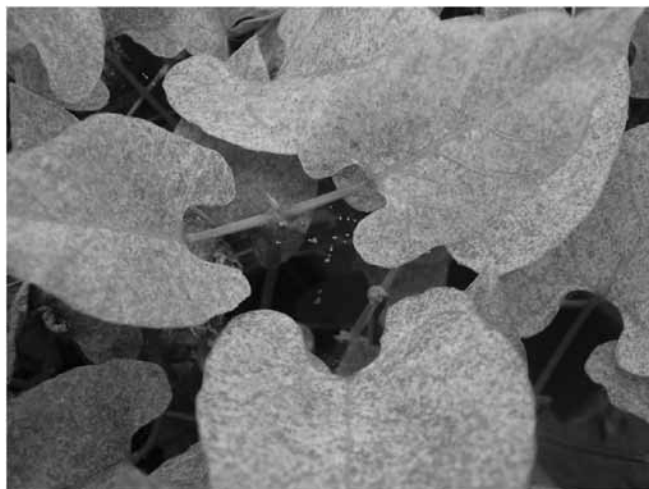


Figure 2. Leaves of plants appeared speckled as spider mites eat the chloroplasts and the plants lose their ability to photosynthesize.



Figure 3. Rows of potted lima bean plants inoculated with spider mites.

Skip estimates that approximately 30,000 pounds of lima beans are used each year for the operation. When asked if the beans could be grown at Liskey Farms, Skip replied with lament that he wished it was possible, but the risk for a killing frost at any month in the Klamath Basin was too high—instead, the beans come from California or Idaho. In order to

prevent disease in the lima bean monoculture, the bean seeds are treated with an herbicide prior to arrival at Liskey Farms. Spent bean plants are cycled into a compost pile and used to grow new bean plants.

THE HISTORY:

The partnership between Liskey Farms and Biotactics began in 2006 with Skip's simple desire to find a cheaper way to heat the greenhouses. "The fuel prices were just killing me," Skip explained, so he typed in "geo-heat" in an internet search engine, and, as he recalls, the first site that popped up was one about Liskey Farms. After conducting a thorough search of other possible geothermal sites which could host the spider mite operation, Biotactics returned to Liskey Farms, moving their mite operation in 2007. "Of all the places we looked," Skip said, "Liskey's was simply the best, especially because of the good water quality." The water quality is such that minerals do not build up in the pipe networks, resulting in a system that is less costly to maintain.

The water isn't the only thing that's comparatively clean. If Biotactics had kept the spider mites in California, they would still be using propane and natural gas to heat the greenhouses. Instead, geothermal water heats the greenhouses and fossil fuels are displaced, or offset. This made the relocation project a good candidate for funding from The Climate Trust. The Klamath County Economic Development Association (KCEDA) assisted Biotactics with securing a 10-year performance-based grant for \$127,500 from The Climate Trust. Under this award, funds are provided to Biotactics as certain levels of emissions are offset. Heat (measured in btus) used in the greenhouse is measured and verified by a third party on an annual basis. The btus measured are then used to calculate the emissions that would have been generated if propane and natural gas were still being used. Because of varying levels of emissions, The Climate Trust could not disclose at this time the projected total emissions reductions that will result from the project.

While the funding from the Climate Trust is helpful, it may still only make up a small percentage of the nearly half million dollars required to move the operation from Romoland to Klamath Falls. The debt continues to decrease, albeit slowly. Skip is hoping his small company can continue to convince agriculturalists and horticulturists that his predator mites are superior and that demand for the predators will grow as more farms pursue organic certification. Large chemical companies and other predator mite suppliers remain Skip's largest competitors.

THE GEOTHERMAL SYSTEM:

Liskey Farms (Figure 4) is a Known Geothermal Resource Area (KGRA). The geothermal resource has been described by Laskin (1978), Lund (1994) and Chiasson (2007).

Groundwater ranging from 190 to 200 °F (87.7 to 93.3°C) is pumped out of three wells on Liskey Farms. The wells are capable of producing several hundreds of gallons per minute: a recent pump test for a renewed water right pumped 2,500 gallons per minute resulting in only a few inches of draw

down. Each well is approximately 300 feet deep with a 40 foot static water level. The water is pumped with 30, 40 and 50 horsepower pumps to a 12,000 gallon tank with a float system. It is then gravity fed to the greenhouses, the aquaculture ponds and Liskey's home. Liskey explained that most of the transit pipe has been replaced with ductile iron pipe bonded and wrapped in plastic. Similar to the pipe protection methods used by utility companies, Liskey has included bags of magnesium at specific locations on the pipes. According to Liskey, the magnesium absorbs the effects of the heat-activated electrolysis that occurs in the ground as a result of the high water temperatures and the soil surrounding the pipe. In this case, only the bags of magnesium require occasional replacement, thus eliminating the need to replace entire sections of pipe.

The geothermal water from the tank is then piped into the greenhouses and distributed using various methods. In the lima bean germination greenhouse, the water is split off the mainline into a series of loops consisting of 2 inch diameter piping secured underneath the growing-bed tables. Skip reports that while this system works, the radiant heat is not always adequate for consistent germination and that more water would be preferred for higher temperatures and higher germination rates. In the spider mite greenhouses, the geothermal water is piped through copper coils of modified radiators (Figure 5). Large fans blow air over the coils and through a large thin plastic distribution tube that runs the length of the greenhouse. The original radiators, Skip explained, consisted of small (3/16 – 1/4 inch) copper tubing unsuitable for the high water pressures resulting from the tank delivery system. Turbulence in the

copper piping caused pipe knocking and would generally accelerate the wear of the piping – at times, this was resulting in the replacement of radiators every 6 months. Biotactics replaced the small copper piping with 1/2 inch copper pipe which solved the knocking and degradation issues. Heated air is also forced between the double-ply polycarbonate walls that form the structure of the greenhouse. This increases the insulation and thermal properties of the greenhouse.

CONCLUDING SUMMARY

Geothermal water at Liskey Farms has been put to use for a variety of purposes since the mid 1900s including potato softening, biodiesel production and greenhouse heating. Currently, 11 greenhouses making up an acre of land are leased by Biotactics to raise spider mites. The spider mite eggs are harvested and shipped to California where they are fed to predator mites and these predators are then sold to agriculturalists as an augmentative biological control (ABC). Both Tracey Liskey and Skip Maltby have been successful in renovating pipe systems outside and inside the greenhouses to reduce maintenance costs and increase the lifetime of the geothermal system. The Climate Trust provided some initial funding to support the relocation and the offset emissions of the spider mite operation. Skip plans to continue and perhaps one day expand Biotactics' operations in Klamath Falls, a plan that is fine by Tracey. "The mites are kind of like retirement for me," Tracey smiles as he looks back on the row of greenhouses. Certainly for a farmer who still raises cattle and hay, it might be as close to retirement as he gets.

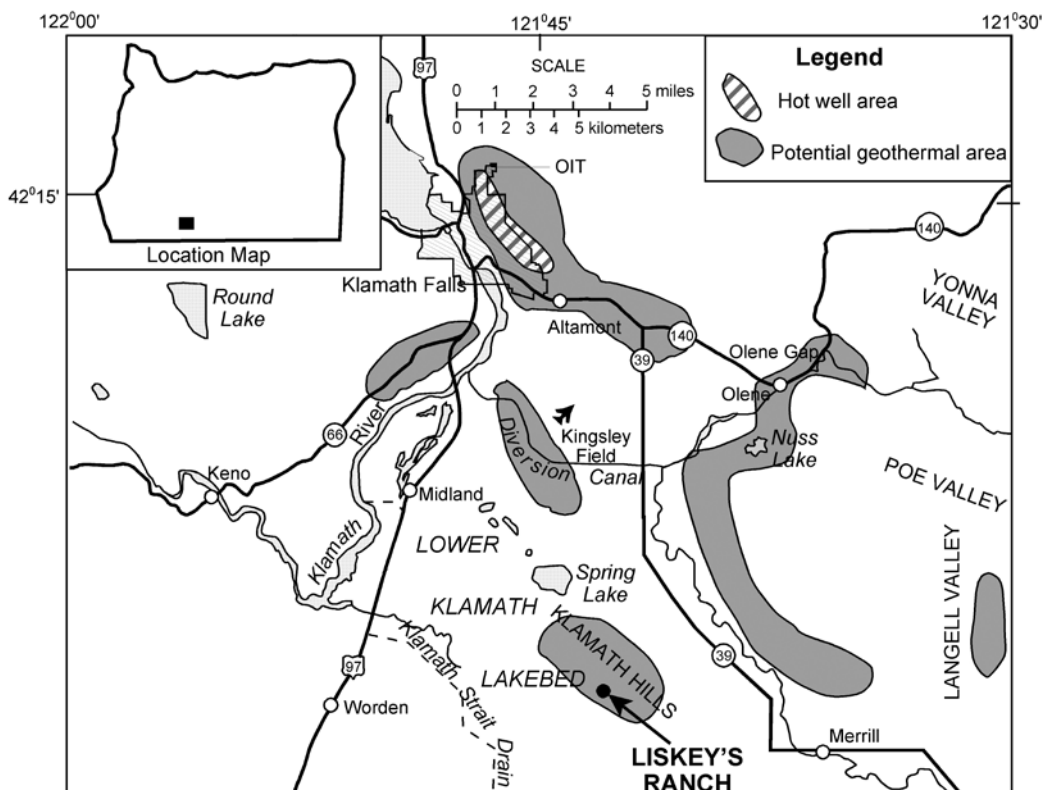


Figure 4. Location map of "Liskey Ranch"

MORE INFORMATION:

Biotactics (spider mites and beneficial predator mites):
www.benemite.com

Geothermal energy utilization: geoheat.oit.edu

The Climate Trust: www.climatestrust.org

ACKNOWLEDGEMENTS

The Geo-Heat Center wishes to thank Tracey Liskey of Liskey Farms and Skip Maltby from Biotactics for their time and the information presented in this article.

REFERENCES

Laskin, S., 1978. "Klamath Greenhouses". *Geo-Heat Center Quarterly Bulletin*, July 1978, Oregon Institute of Technology, Klamath Falls, Oregon.

Lund, J., 1994. "Agriculture and Aquaculture Cascading the Geothermal Way". *Geo-Heat Center Quarterly Bulletin*, November 1994, Oregon Institute of Technology, Klamath Falls, Oregon.



Figure 5. The radiator/fan heating unit used to heat the spider mite greenhouses.



GEO-HEAT CENTER
Oregon Institute of Technology
Klamath Falls, OR 97601-8801

Non-Profit
Organization
U.S. Postage
PAID
Klamath Falls, OR
Permit No. 45