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Research highlights

Recent articles from the Agricultural Experiment Station campuses and UC ANR's county offices, institutes and research and extension centers.

Grafting standard tomato varieties onto pathogen-resistant rootstocks may be as effective as soil fumigation

In Europe and Asia, producers of fresh market tomatoes often use grafted plants — scions of a popular market variety grafted on to rootstocks that are especially vigorous or resistant to soilborne diseases. California growers rarely use grafted plants now, but there's increasing interest in whether grafting could maintain high yields in pathogen-infested fields without soil fumigation.

A worldwide review of all available published trial data on the fruit quality and yield of grafted tomatoes was recently undertaken by project scientist Michael L. Grieneisen and professor Minghua Zhang in the Department of Land, Air and Water Resources at UC Davis, and UC Cooperative Extension farm advisors Brenna J. Aegerter (San Joaquin County) and C. Scott Stoddard (Merced County). The data came from 159 publications and 126 locations around the world, including a few in California.

The researchers warn that grafting is no magic bullet, but it may allow growers to reduce fumigant use. In the small number of trials that directly compared grafted plants to fumigation treatments in pathogen-infested fields, the grafted plants often gave higher yields. Other studies without fumigation treatments showed that pathogen resistance in some rootstocks was often strong enough to achieve high yields in pathogen-infested conditions. Fruit quality seldom varied significantly between grafted and non-grafted plants.

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Brenna Aegerter, UCCE San Joaquin County

Maxifort was the most common rootstock used in the trials. It is resistant to seven pathogens: corky root rot, Fusarium wilt races 1 and 2 (but not 3), Fusarium crown and root rot, Verticillium wilt, nematodes and tomato mosaic virus. That makes it a good candidate for fields, or parts of fields, that cannot be fumigated because of regulatory restrictions. In late July 2018, the authors harvested their third year of California grafted tomato trials, and are preparing a more California-focused article on their results.

Grieneisen ML, Aegerter BJ, Stoddard CS, Zhang M. 2018. Yield and fruit quality of grafted tomatoes, and their potential for soil fumigant use reduction: A meta-analysis. Agron Sustain Dev 38:29. https://doi.org/10.1007/s13593-018-0507-5

24 hours of high temperature affects avocado ripening, causes disorders

California avocados often are exposed to high temperatures after harvest, either in the field or during preconditioning (ethylene treatment), especially in summer. It's been known that long periods of high temperatures can delay ripening time and reduce fruit quality, but a new study indicates pronounced effects after only short periods of high temperature following harvest. Authors of the study concluded that it's important to maintain avocados at temperatures below 25°C following harvest and that the ideal temperature to ripen the fruit is 20°C. The authors also found that ripening below 20°C resulted in significantly longer ripening times and resulted in poorer coloration of the ripened fruit.

Mary Lu Arpaia, UC Cooperative Extension specialist, Jim Sievert and Sue Collin, staff research associates (retired) in the Department of Botany and Plant Sciences at UC Riverside, working with David Obenland, research physiologist with the USDA Agricultural Research Service, Parlier, studied for two seasons holding avocados from multiple harvest times for the first 24 or 48 hours of the ripening period at

Brenna Aegerter, UCCE San Joaquin County

high temperatures (20°C to 35°C), with and without ethylene. In the third season, they made a detailed assessment of ripening temperatures (15°C to 25°C) on ripening time and fruit quality.

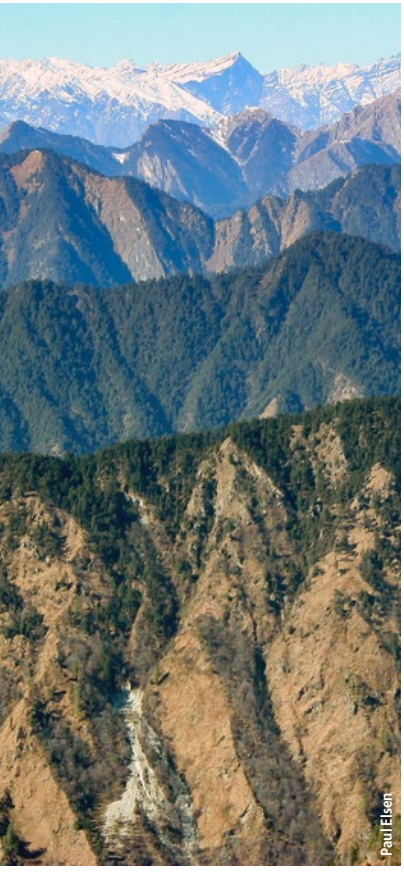
Results from the first two seasons showed that even a 24-hour exposure to temperatures of 25°C and above inhibits ripening and increases postharvest disorders such as stem end rot and body rot. In season 1, the incidence of stem end rot increased from 9.7% at 20°C to 32.3% at 35°C, and body rot increased from 3.9% to 20.2% for the same treatment comparison. Ethylene applied during the exposure period was ineffective in preventing the disorders.

In the third-season trial, temperature was also shown to be critical. Fruit ripened below 20°C took slightly longer to ripen. Additionally, the authors found that the ripened fruit at either 15°C or 18°C remained more green then fruit ripened at the higher temperatures. Avocados ripened above 20°C were more likely to develop pink discoloration in the mesocarp. Ripening temperature had no effect on overall likeability, or ratings of grassy or rich flavor.

Arpaia ML, Collin S, Sievert J, Obenland D. 2018. 'Hass' avocado quality as influenced by temperature and ethylene prior to and during final ripening. Postharvest Biol Tec 140:76–84.

Aiding climate-stressed species by protecting habitat across elevations

Mountainous areas provide habitat for disproportionately high numbers of plant and animal species. As the planet warms, species native to mountainous areas may adapt to altered climate conditions by extending their ranges to different altitudes. Protecting mountain habitat can meaningfully contribute to species survival and diversity — but if protected areas are established at only a portion of the elevations over which species will be moving, they may ultimately fail to preserve species.


Paul Elsen

Fewer than 25% of elevations in the Himalayan Mountains — a global biodiversity hotspot — contain enough protected areas to safeguard species affected by climate change.

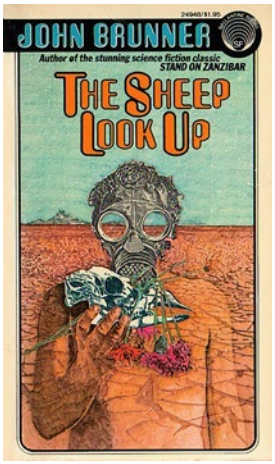
To understand elevation patterns in existing protected areas, and to gain insight into the elevations at which future protected areas might optimally be established, researchers led by Paul R. Elsen — a conservation research fellow in UC Berkeley's Department of Environmental Science, Policy, and Management — analyzed the elevational distributions of more than 44,000 protected areas situated across more than 1,000 mountain ranges. Within various geographical regions, the team calculated the proportion of elevational gradients that are protected across at least 17% of their extent (a minimum standard established by an international agreement known as the Convention on Biological Diversity).

Elsen and his colleagues found that, if a strict definition of "protected areas" is employed, about three-quarters of the world's mountain ranges fail to meet the Convention's 17% protection target across at least one-half of their elevational gradients. The research team also determined that nearly 40% of the world's mountain ranges do not contain any protected areas at all. These deficiencies could, as climate change progresses, undermine protected areas' ability to protect biodiversity.

Elsen and his colleagues suggest that elevation zones that are currently underrepresented by protection be prioritized when future protected areas are established. Otherwise, they say, protecting 17% of the land distributed across mountain regions' elevational gradients will require that nearly half the world's total mountainous area be incorporated into protected areas.

Elsen PR, Monahan WB, Merelender AM. 2018. Global patterns of protection of elevational gradients in mountain ranges. P Natl Acad Sci USA 115(23):6004–9. https://doi.org/10.1073/pnas.1720141115

Going deeper into social vulnerability: A study of a dystopic novel



The Sheep Look Up by John Brunner

The 1972 necro-futurist novel *The Sheep Look Up* by John Brunner is about the opposite of sustainability. It depicts a society where social and ecological resilience has been fatally undermined. The "sheep" are humans who are so concerned with everyday problems of survival that they cannot comprehend the whole picture of what's happening or adapt, so they remain passive and the global ecological and economic apocalypse occurs. The novel may be useful in environmental science studies, to contemplate human agency in a world going wrong.

Kate O'Neill, associate professor in the Department of Environmental Science, Policy, and Management at UC Berkeley, has analyzed the themes and topics of the novel that resonate for social science theorists and teachers in environmental social sciences. It provides a counterfactual analysis by opening "a window into how the world might have been without, for example, the U.S. Environmental Protection Agency (EPA) or the U.N. Environment Programme (UNEP)," she writes. It warns what will happen if we do not act, and it models the transition from a bad situation to an apocalyptic one.

Environmental changes are hard to see on the ground and therefore hard to grasp. "Storytelling and the building of characters, settings, and a novel's trajectory" help with that, writes O'Neill. She brings in examples from New York magazine, television and film. Any imaginative work that helps people draw connections "serves a positive function in academic disciplines that deal with complex problems and uncertain futures," O'Neill says. She especially recommends *The Sheep Look Up* as an unconventional type of "scenario analysis," to discuss the complex conditions under which communities become vulnerable to an unraveling of the social fabric and how things come back together again.

O'Neill K. 2018. The sheep look forward: Counterfactuals, dystopias, and ecological science fiction as a social science enterprise. Elem Sci Anth 6:44. https://doi.org/10.1525/elementa.303



Researchers determined that while large grocery stores in low-income areas generally offered high-quality produce, they charged 27% more for produce, on average, than comparison supermarkets. Convenience stores, meanwhile, charged more than twice as much, on average, for lower-quality produce.

Fresh produce in low-income areas: High cost and low quality

Fresh fruit and vegetable consumption lowers the risk of chronic disease and delivers other important health benefits. While fewer than 10% of Americans meet dietary recommendations for fruits and vegetables, people of low socioeconomic status consume even fewer fruits and vegetables than their higher-income counterparts. A number of studies have examined whether healthy food is less available in low-income communities than in higher-income locations, but little research has focused on the quality and affordability of healthy food in low-income communities.

To redress this gap, a team of researchers led by Wendi Gosliner — a project scientist at the Nutrition Policy Institute of the UC Division of Agriculture and Natural Resources — analyzed data that the California Department of Public Health gathered between 2011 and 2015 from stores in 225 low-income neighborhoods in the state. Gosliner and her colleagues analyzed produce availability, quality and price in the nearly 1,500 retail stores in the database, which included large groceries, small markets and convenience stores. Gosliner's team sought to identify patterns involving store type and produce availability, quality and price. The team also examined stores' participation in the Supplemental Nutrition Assistance Program (SNAP) and the Supplemental Nutrition Program for Women, Infants, and Children (WIC).

The researchers determined that prices were higher in low-income neighborhoods than in a set of comparison stores, with prices in large grocery stores in these areas charging 27% more for produce, on average, than comparison supermarkets; convenience stores, meanwhile, charged more than twice as much, on average, as comparison supermarkets. While large grocery stores in low-income areas generally offered high-quality produce, few convenience stores sold high-quality fruit (25%) or high-quality vegetables (14%). Stores participating in nutrition assistance programs, however, featured more, more varied, and higher-quality produce than did nonparticipating stores. The researchers suggest that more work is needed to determine how to provide low-income communities with better access to high-quality, affordable produce. They also suggest that programs such as WIC and SNAP might represent part of the solution.

Gosliner W, Brown DM, Sun BC, et al. 2018. Availability, quality and price of produce in low-income neighbourhood food stores in California raise equity issues. Public Health Nutr 21(9):1639–48. https://doi.org/10.1017/S1368980018000058

A bird repellent stops voles from girdling citrus trees

Voles girdle fruit trees and vines, causing extensive damage near the base of the trunks. Tree guards and rodenticides may control them, but the guards are expensive and rodenticide use is very restricted in food crops. A bird repellent, anthraquinone, may be the answer growers have been seeking.

Two scientists in the Department of Wildlife, Fish, and Conservation Biology at UC Davis — UC Cooperative Extension specialist Roger Baldwin and staff research associate Ryan Meinerz — worked with Scott Werner and Gary Witmer from the USDA National Wildlife Research Center in Colorado to trial anthraquinone on 1-year-old citrus trees planted in 3.3 meter-by-2.1 meter fiberglass tubs recessed in the ground. Anthraquinone is a naturally occurring compound that works as a postingestive repellent — after ingesting it from treated material, birds and voles avoid it.

Anthraquinone was applied to the base of the tree trunks in 10 of the tubs. The control consisted of untreated trees in another 10 tubs. Half of each tub had been planted with cover crops known to be liked by voles, and the other half was kept vegetation free. Two voles were released in each tub and tree trunks were monitored for damage weekly for 5 weeks in summer and 6 weeks in spring.

The reduction in vole girdling to treated trees was 90% to 100% when compared with untreated trees across both seasons. No girdling damage was observed on treated trees in vegetation-free areas during summer, although vegetation removal did not seem to impact vole girdling damage during spring. Damage to trees in the first week of treatment, a necessary step for voles to learn to avoid the repellent, was minimal and unlikely to have a long-term impact on tree health. The repellent was effective through the length of the trial periods, with efficacy likely extending well beyond the observed time frame, but more research is needed on its longevity to assess its cost effectiveness in relation to tree guards.

Baldwin RA, Meinerz R, Witmer GW, Werner SJ. 2018. The elusive search for an effective repellent against voles: An assessment of anthraquinone for citrus crops. J Pest Sci 91:1107–13. https://doi.org/10.1007/s10340-018-0979-8



Anthraquinone application, *left*. Anthraquinone, a naturally occurring compound used as bird repellent, can reduce the girdling of fruit trees and vines by voles, *right*. In a trial using citrus trees, researchers found it reduced vole girdling by 90% to 100%.