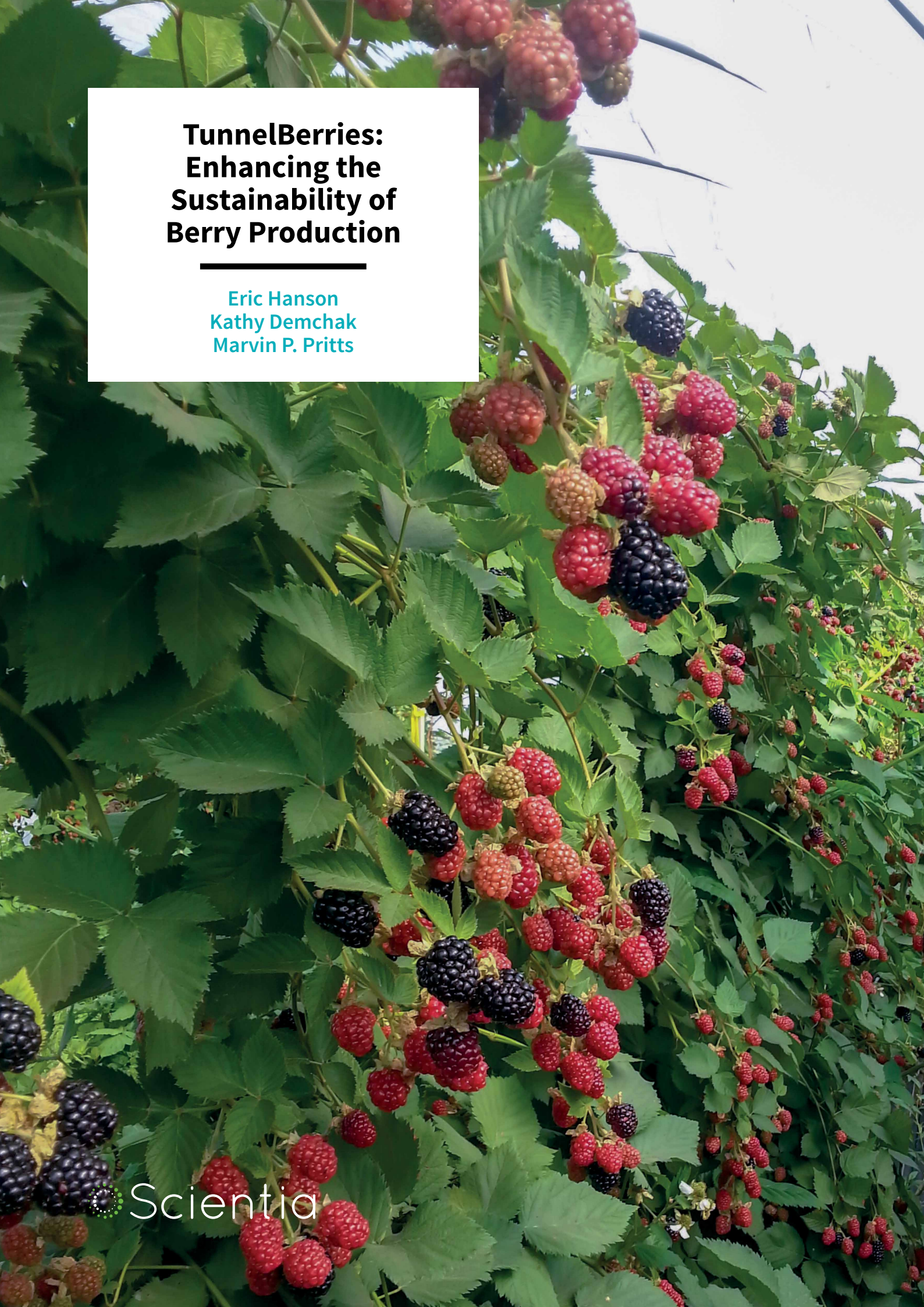

TunnelBerries: Enhancing the Sustainability of Berry Production

Eric Hanson
Kathy Demchak
Marvin P. Pritts

Scientia

TUNNELBERRIES: ENHANCING THE SUSTAINABILITY OF BERRY PRODUCTION

In certain areas of the US, local berry growers face difficulties in meeting the growing customer demand for high-quality berries, while also managing pests in sustainable ways. Aware of these challenges, researchers from different universities, including Michigan State, Penn State and Cornell Universities have been collaborating on a project called TunnelBerries. Their aim is to conduct research related to berry growing and provide berry crop producers with useful information, paving the way towards the use of forward-looking practices.

Challenges Faced by Berry Growers

Over the past two decades, consumer demand for berries in the Northeastern and upper Midwestern US has been on the rise, nearly doubling in the case of strawberries to almost eight pounds per person, according to Marvin Pritts of Cornell University. Currently, these regions host over half of the nation's strawberry and raspberry farms, as well as many farms growing other fruits. Local open-field berry growers, however, can only supply a limited portion of the total demand due to climate-related and environmental challenges.

The climate in these regions is characterised by cold winters and short growing seasons, limiting the period in which berries can be marketed. For example, strawberries grown in open-field production are typically harvested for three to four weeks in late spring and early summer. Furthermore, hot, humid summers with frequent rainfall negatively impact berry quality and shelf-life and encourage growers to use pesticides. Producing day-neutral strawberries and raspberries in polytunnels (or 'hoop houses') can extend the harvest season to five months, while also protecting crops from disease, insect pests and weeds, decreasing farmers' reliance on pesticides.

However, manufacturing the plastic films used in hoop houses requires fossil-fuels, and this plastic is not readily recycled, leading to negative environmental impacts. Therefore, research investigating the challenges faced by berry growers in the Northeast and upper Midwest, as well the advantages and disadvantages of specific solutions to tackle these challenges, is of crucial importance. These studies can help berry producers to make more informed choices when trying to counteract adverse climate conditions.

With this in mind, a team of researchers from different US universities led by Eric Hanson at Michigan State University has been working on the project 'Optimizing Protected Culture Environments for

Berry Crops', known as 'TunnelBerries'. The project was designed to aid berry crop production through the evaluation and development of more sustainable protective structure and pest management solutions.

The TunnelBerries Project

TunnelBerries involves a large group of researchers and experts in a variety of different fields, including horticulture, entomology, economics and plastics recycling. 'TunnelBerries brings together a lot of people with different areas of expertise to collaborate on one large project,' says Kathleen Demchak, a researcher involved in the project. 'We wanted to better understand what protected culture options were available to everyday growers at an affordable cost.'

Alongside her colleagues, Eric Hanson, Marvin Pritts and others, Demchak carried out extensive research investigating and evaluating different solutions to counteract obstacles in berry crop production. Their hope was to create a reliable pool of information that berry growers can access when seeking guidance on how to increase productivity, length of harvest season, or berry quality. The research team also wished to encourage change in other aspects of berry crop production by testing new varieties, different types of tunnel coverings, planting dates, fertiliser rates, plant manipulations, and pest management techniques.

Their findings and other valuable resources are published on the TunnelBerries website, where growers can learn about different crop protection strategies and receive general guidance. In addition to conducting research, the TunnelBerries team also participates in outreach activities to promote dialogue with growers, extension personnel, and other researchers in the field.

'We have given at least 100 in-person presentations to growers at meetings, given tours of our research sites to growers and extension personnel, and conducted workshops on high tunnel production,' says Demchak. 'We have also published journal articles, but there will be more to come as we continue to analyse data from the project.'

Comparing Different Tunnel Coverings

Two types of hoop houses used to protect berry crops from the environment are high tunnels and low tunnels. As their names would suggest, high tunnels are taller in size and thus are typically used to protect taller crops (such as raspberries), while low tunnels are only used over smaller plants (including strawberries). These tunnels can be built using a variety of materials and their key advantage is that they produce an alternative environment which is more suitable for growing.

A key focus of the team's research was to investigate the microclimate effects of different protective structures; for instance, how they change temperature and light, and to what extent these changes can affect plant growth and pest incidence. 'We tested different film coverings with different light-transmitting properties in replicated trials of raspberries and strawberries at a facility at Penn State,' Demchak explains. Such studies comparing the effects of different protective films had previously been limited, partly due to the scarcity of facilities where tunnels can serve as experimental units.

Many of the findings collected by Hanson, Pritts, Demchak and their colleagues confirmed the positive effects and yield increases associated with protective structure use, with high tunnels doubling or even quadrupling raspberry total yields compared to uncovered production. This means that using protective structures could lead to more sustainable practices, as farmers would be able to produce larger quantities of berries in smaller patches of land.

In their comparisons of high tunnel plastic covering films, the researchers found that two varieties of raspberries responded in a similar way to different plastic coverings. However, while one variety showed an 11% difference in yield between plastics, the second showed a 23% difference when averaged over 2 years.

'This is from changing from a plastic we normally would have recommended to one that we thought would be too warm for optimal raspberry growth during the summer,' Demchak explains. 'This means we could increase yield without increasing costs or adding more inputs – all we did was use a different plastic film. On the other hand, we found no significant differences between coverings for strawberries, although this may have been because the strawberries were exposed to significant amounts of ambient sunlight for most of the growing season when tunnel sides were open.'

In addition, the researchers observed that all high tunnel plastics decreased the presence of a disruptive insect species known as the Japanese beetle, which can have detrimental effects on raspberry crops. Interestingly, plastics that blocked UV light decreased the presence of this species the most. 'Japanese beetle population reductions of 85 to 98% were

achieved without the use of pesticides depending on the year and variety,' Demchak says.

Working with low tunnels as a lower-cost alternative to high tunnels for protecting strawberry crops, researchers working on the project found that low tunnels increased the marketable yields of strawberries similarly regardless of the type of plastic used. This could be because the environment in these tunnels is more open and thus their effects on light and temperature are less marked. As summed up by Pritts: 'The influence of a simple protective sheet of plastic overtop a strawberry plant is remarkable.'

Reducing Pesticide Use

A further goal of the TunnelBerries team was to investigate and develop strategies for reducing pesticide use in berry production, while also managing crop diseases and preventing pest infestations. In recent years, the arrival of an insect species called spotted wing drosophila has made it particularly difficult for producers to grow soft fruit crops without using pesticides.

TunnelBerries team members at Michigan State University investigated non-chemical approaches for managing spotted wing drosophila infestations of berry crops. They identified certain pesticide-free strategies that were helpful, including using exclusion netting, harvesting fruits every one or two days, and bagging and removing infested waste berries to minimise dropped berries. These pest management techniques appear to be most effective in high tunnels, as environmental conditions allow for greater control over operations, such as harvesting.

The team also investigated whether different plastic films can have different effects on pesticide residues. They found that reduced UV transmission resulted in 50% greater residues compared to UV-transparent plastics and 60% compared to uncovered tunnels. This essentially means that the use of UV-blocking plastic could prolong the effect of pesticides, allowing for fewer applications. 'However, this also means that further testing needs to be done to ensure safety,' Demchak says.

Towards More Effective Berry Production

The TunnelBerries team collected various interesting findings, which highlight the benefits of some protective films over others, particularly in their ability to affect the microenvironment including light quality, and thus yields, pest behaviour, and pesticide longevity.

In the future, the observations gathered by the TunnelBerries team could sway producers towards more responsible and effective practices, and assist them in choosing protective structures, while also encouraging them to reduce the use of pesticides and better manage the environment including light quality. The researchers have also developed comprehensive low tunnel strawberry production and high tunnel raspberry production guides, which incorporate other findings from the project and provide up-to-date information for US berry crop growers.

Despite the advantages of plastic protective structures for berry production, numerous important challenges still need to be addressed. Environmentally, in fact, the use of plastic in agriculture, as in any other setting, is far from ideal.

'I'd like to see continued involvement of those who work in the plastic industry and development of solutions through perhaps increased recycling as a short-term solution and development of biodegradable high tunnel coverings in the long-term,' says Demchak. 'There are many hurdles to clear before these solutions can be put in place, but I think the key lies in maintaining open communications and a dialogue between everyone involved in these industries.' The group hopes to build on what they accomplished so far and train a new generation of researchers who might come up with entirely new solutions.

'The potential for protected agriculture is enormous,' says Demchak. 'Our work showed ways to improve yields and pest control, but more importantly, the benefits are accessible to even those who are land-limited or don't currently own farms. This includes both new growers who cannot afford to purchase or rent large tracts of land, or those who only have access to small plots, including those in urban environments.'

'Berry marketers and consumers desire a reliable supply of healthy and sustainably grown berries,' adds Hanson. 'We think that the TunnelBerries information can help growers in short season regions to produce more berries in a profitable and sustainable manner.'

Meet the researchers

Eric Hanson
Department of Horticulture
Michigan State University
East Lansing, MI
USA

Kathy Demchak
Department of Plant Science
Penn State University
University Park, PA
USA

Marvin P. Pritts
School of Integrative Plant Science
Cornell University
Ithaca, NY
USA

Hanson holds a PhD in Horticulture from Oregon State University, an MS in Plant Science from the University of Maine and a BS in Biology from Nasson College. He is currently a Professor at Michigan State University, where he carries out extensive research into fruit production. In addition to his research, Hanson provides guidance to berry producers through online resources, meetings and field demonstrations. His areas of expertise include fertiliser use in fruit production, high-tunnel berry production, cover crops, and weed management.

E: hansone@msu.edu

Demchak holds an MS in Horticulture from Virginia Tech and a BS in Horticulture from Pennsylvania State University, where she is now a Senior Extension Associate in the College of Agricultural Sciences. Her key duties include conducting in-depth research related to production technologies for berry growing and disseminating this information through presentations, scientific articles, and publications. Her studies specifically focus on technologies that can improve the sustainability of berry production, reducing adverse environmental impacts while also maximising crop productivity.

E: efz@psu.edu

Pritts holds a PhD in Horticulture from Michigan State University, an MS in Biology from the University of South Carolina and a BS in Biology from Bucknell University. For 13 years, he worked as the Chairman of Cornell University's Department of Horticulture, and he is now the Director of Undergraduate Studies within the School of Integrative Plant Science. His research primarily focuses on developing sustainable production methods for berry crops.

E: mpp3@cornell.edu

KEY COLLABORATORS

Dr Rufus Isaacs and Heather Leach, Michigan State Univ.
Dr Richard Marini, Dr Dennis Decoteau, Matthew Cooper, and Maria Cramer, Penn State Univ.
Dr Rebecca Sideman and Kaitlyn Orde, Univ. of New Hampshire
Laura McDermott, Cornell University
Dr Mary Thomas and Heidi Anderson, Univ. of Minnesota
Dr Nigel Paul and Dr Crispin Halsall, Lancaster Univ., UK
Dr Jason Moore, Arid Agritec, Ltd

PROJECT WEBSITE

www.tunnelberries.org

ACKNOWLEDGEMENTS

This work is based upon research supported by the USDA National Institute of Food and Agriculture, Section 7311 of the Food, Conservation and Energy Act of 2008 (AREERA), Specialty Crops Research Initiative under Agreement 2014-51181-22380 and Hatch appropriations to the various states. Special thanks to the Pennsylvania Vegetable Growers Association, the New York State Berry Growers Association, the Michigan State Horticultural Society, and Rimol Greenhouse Systems, Inc, for providing funds and materials to the project. Thanks to our grower cooperators Fred and Linda Koenigshof of K & K Farms, Coloma, MI, and our grower and industry advisory committee members. Finally, thanks to the many staff members and students who contributed their time and efforts to this project.

TunnelBerries
Sponsored by USDA-SCRI