

# Are radiant heat retention strategies beneficial to HIGH TUNNEL PRODUCTION?

We wanted to find out. And we did!

Jeff Edwards and Milton Geiger

We fight for every growing-season day we can get in Wyoming.

Many growers have constructed high tunnels to extend the growing season. Water-filled black barrels and an additional layer of skin are strategies some have used to retain heat.

Wyoming small-acreage growers have asked UW Extension, “Are radiant heat retention strategies beneficial to high tunnel production? More importantly, can these strategies increase production quantity and quality over traditional high tunnel production?”

Little data was available to support or deny claims these strategies can retain heat and extend the growing season beyond that of a traditional high tunnel.

## On The Ground Research

To gather applied research data, the Wyoming Department of Agriculture funded a demonstration trial commencing in 2011 with cooperation of the University of Wyoming Agricultural Community Resources for Everyday Sustainability (ACRES) student farm. The project sought to

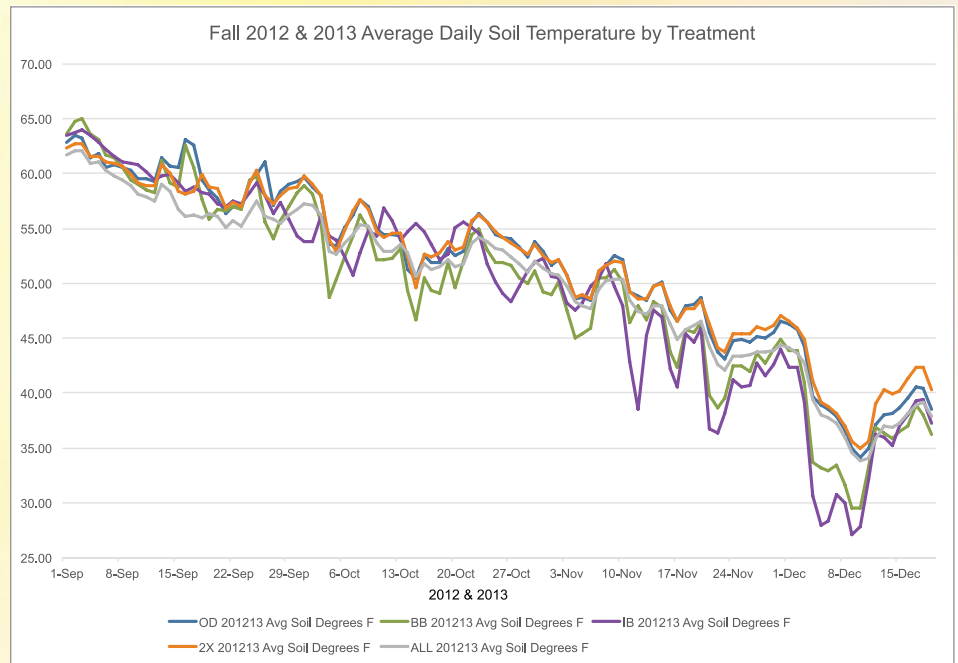


Figure 1.

understand if several simple heat retention strategies were worth the cost of investment for Wyoming’s high tunnel growers.

Five traditional-style hoop high tunnels were constructed on the ACRES student farm in Laramie during the spring of 2011. The structures – which are still in operation – are 12 feet by 32 feet (384 square feet) with roll-up sides. The high tunnel structures were modified to investigate one heat retention configuration each.

The individual high tunnels for this demonstration included:

- **OD = Original Design.** This is a traditional design hoop structure with a single woven poly cover

and rollup sides. There was no additional heat retention strategy utilized in this structure.

- **IB = Insulated Barrier.** A 4-inch wide trench was dug 2 feet deep. Two-inch, high-density foam insulation (R-9) was placed into the trench, and the trench was back-filled. A traditional design, single woven poly cover high tunnel with rollup sides, was constructed over the insulation barrier at ground level. The entire perimeter of the high tunnel sits on top of the ground on top of the insulated barrier.
- **BB = Black Barrels.** A traditional-design, single woven poly cover

high tunnel with rollup sides. Eight, blue, 55-gallon poly barrels were painted black and placed inside the high tunnel along the north wall. These barrels were then filled with water.

- **2X = Poly Cover.** A traditional-design, single woven poly cover high tunnel with rollup sides. Batten tape was attached to the structure between each of the ribs. This pulled the first layer down forming a “v” between each rib. A second layer of poly cover was attached over the first. The “v” allowed for air separation chamber between each rib.
- **All =** A traditional-design, single woven poly cover high tunnel with rollup sides. This treatment included the insulated barrier, the black barrels, and the two layers of woven poly cover as described above.

### And the Results Are ...

Did any of these heat retention strategies extend the growing season?

To understand this question, soil and ambient air temperature were recorded within each of the structures. None of these strategies actually extended the growing season based on temperature data collected. Most of the solar radiation collected as heat during the day is lost during the cold temperatures of night. Sure, there are slight differences in temperature between treatments – but they all follow a similar trend (Figure 1 page 20). The total number of growing days did not increase in any of the treatments.

What about the economics of the treatments? Table 1 contains the cost of materials for treatment. Overall, the radiant heat treatments

add a slight amount to the cost of each project – to understand if it is worth it, you will need to look at the yield data.

Do these heat retention strategies increase production?

Three crops were chosen and produced within each of the treatments: tomatoes (Figure 2), English peas (Figure 3), and lettuce greens (Figure 4). Harvest weights were collected in each high tunnel and totaled for each crop. The data shown for each crop harvested in each of the high tunnel treatments is expressed as a percent of the total crop harvested from all high tunnels. For example: Tomato yield for the OD (original design) high tunnel was 12.6 percent of the total harvested for all high tunnels for the duration of the entire project.

Results are crop dependent and, in most instances, greater yield was recorded in the high tunnels with a heat retention treatment than in the



### Understanding Cost of Treatments

TREATMENT	OD <sup>1</sup>	2X <sup>2</sup>	IB <sup>3</sup>	BB <sup>4</sup>	ALL <sup>5</sup>
<b>Base Materials</b>	\$1,200.00	\$1,200.00	\$1,200.00	\$1,200.00	\$1,200.00
<b>Second Skin</b>		\$110.00			\$110.00
<b>Insulated Barrier<sup>6</sup></b>			\$217.00		\$217.00
<b>Barrels</b>				\$165.00	\$165.00
<b>TOTAL</b>	<b>\$1,200.00</b>	<b>\$1,310.00</b>	<b>\$1,417.00</b>	<b>\$1,365.00</b>	<b>\$1,692.00</b>
<b>Cost per 'farmable' square foot<sup>7,8</sup></b>	\$3.13	\$3.41	\$3.69	\$4.21	\$5.22

1 - OD, Original design with single polyskin layer.

2 - 2X, Two polyskin layers.

3 - IB, Insulated barrier

4 - BB, Black barrels.

5 - ALL, 2X polyskin, insulated barrier, and black barrels.

6 - Insulated barrier included \$135.00 for materials and \$82.00 for trencher rental (per each treatment).

7 - Farmable square feet of a high tunnel is the total square footage of the base, 12 ft. X 32 ft = 384 square ft. per high tunnel.

8 - Farmable square feet of HT's BB and ALL are reduced by 60 square feet due to footprint of barrels.

**Table 1.**

original design without a heat retention treatment (except for lettuce).

Is this information definitive?

No, but it does shed some light on the original question – Are radiant heat collection strategies beneficial for crop production in high tunnels?

### High Tunnels Are Effective Extenders

Use of a high tunnel in Wyoming can, at a minimum, extend the growing season by 30 days in the spring and by 30 days in the fall. Data suggest these treatments do not extend the growing season much beyond that of a traditional single cover high tunnel. As soil temperatures approach freezing, all plant growth stops. Certain crops may be able to withstand these cold temperatures and resume growth in the spring when temperatures become more favorable, but none of the treatments increased the growing season length more than what the original design would have.

There does appear to be a slight yield bump as a result of attempting to retain more radiant energy, but this is expensive extra production.

In Wyoming, we have many more sunny days (radiant energy) than many other states conducting high tunnel research. It is possible the number of sunny days has a greater impact on season length (regardless of the temperature) than any other factor. More sun means more production.

The most economical option (based on these data) for growing tomatoes or peas would be to either leave the high tunnel with a single skin or add a second layer of polyskin.

We welcome further research on this topic or hearing from readers about their own experiences with radiant heat retention strategies.

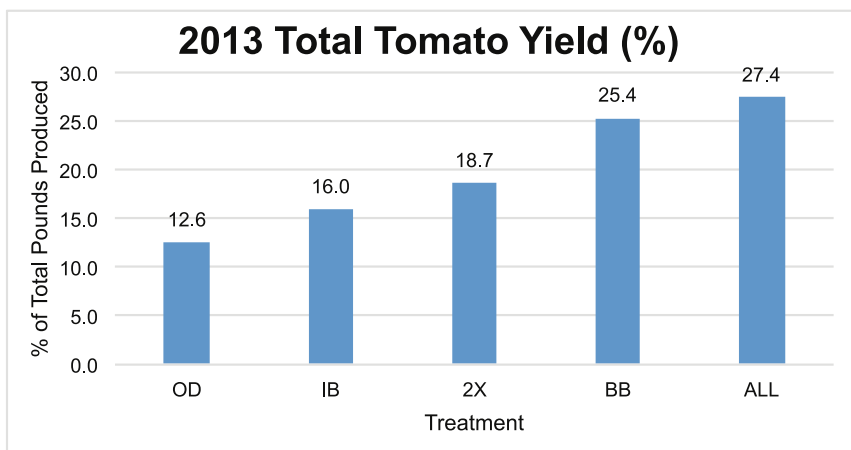


Figure 2.

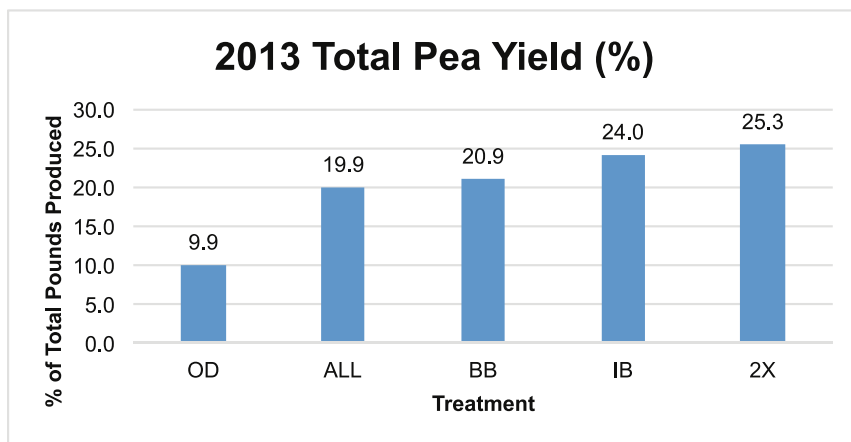


Figure 3.

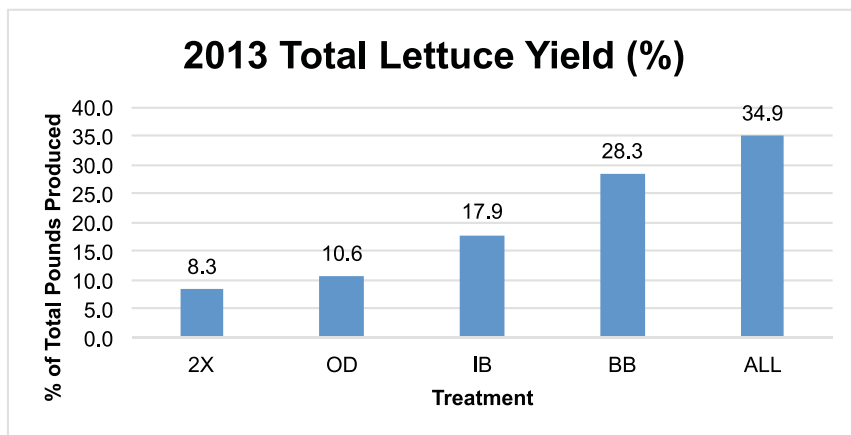


Figure 4.

**Jeff Edwards** is the University of Wyoming Extension pesticide education coordinator and has constructed high tunnels across Wyoming. **Milt Geiger** is UW Extension’s energy coordinator. Edwards can be reached at (307) 837-2000 or at [jedward4@uwyo.edu](mailto:jedward4@uwyo.edu). Geiger is at (307) 766-3002 or at [megeiger1@uwyo.edu](mailto:megeiger1@uwyo.edu).