

# Crops and Cover: Winter Growing in Central and Northern Indiana

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## Introduction

In the North Central region of the U.S. vegetables harvested from high and low tunnels in October through April provide value to farms, consumers, and the local food system. In unheated structures keeping temperatures high enough to prevent crop injury, and if possible, to allow growth is important to make it a viable system. Many growers use row covers inside the tunnel to reduce heat loss, but specific practices differ. Sometimes row covers are held above the crop on hoops and sometimes they rest on top of the crop like a blanket. With funding from a SARE Partnership grant we compared spinach production using row covers on hoops or resting on the crop on three farms. Over the last two winters we have also monitored air and soil temperature in high and low tunnels on farms.

## Partner Farms

### Clay Bottom Farm, Goshen

Two high tunnels in the project:  
Unheated: 90X30X14, single layer poly  
Heated: 90X30X14, double layer poly, 28F

### River Ridge Farms, Roann

Two high and one low tunnel in the project:  
Unheated: 96X30X12, double layer poly  
Heated: 96X30X12, double layer poly, 32F  
Low tunnel: 30X6X3, row cover with plastic added in very cold weather.

### Eden Prairie Farm, Greenfield

One high and one low tunnel in the project:  
Unheated, 'caterpillar' tunnel: 50X12X7, single layer poly  
Low tunnel: 50X4X4, row cover

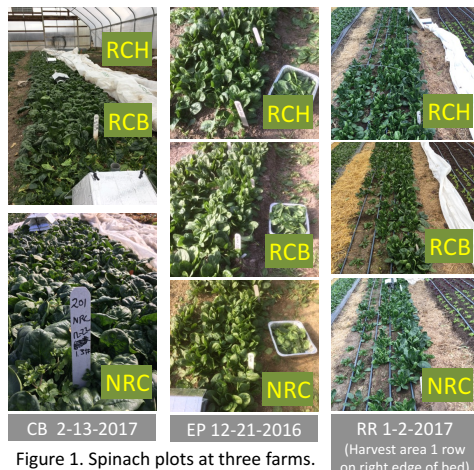


Figure 1. Spinach plots at three farms. (Harvest area 1 row on right edge of bed)

## Spinach Methods

	CB	EP	RR
Plant Date	10/10	10/3	10/3
Harvest Dates			
Heated (HHT)	12/22	-	12/5, 12/20, 1/2, 1/25, 2/8
Unheated (UH)	12/22	11/15, 12/12, 1/18, 2/14	12/5, 12/20, 1/2, 1/25, 2/8
Low tunnel (LT)	-	11/15, 12/5, 2/6	-

Three row cover treatments used in unheated tunnels:

1. No Row Cover (NRC)
2. Row Cover Supported by Hoops (RCH)
3. Row Cover Blanket on Crop (RCB)

Two replications of each treatment at each farm in a randomized complete block design.

Row Covers: medium weight, 0.9 oz. / sq.yd.

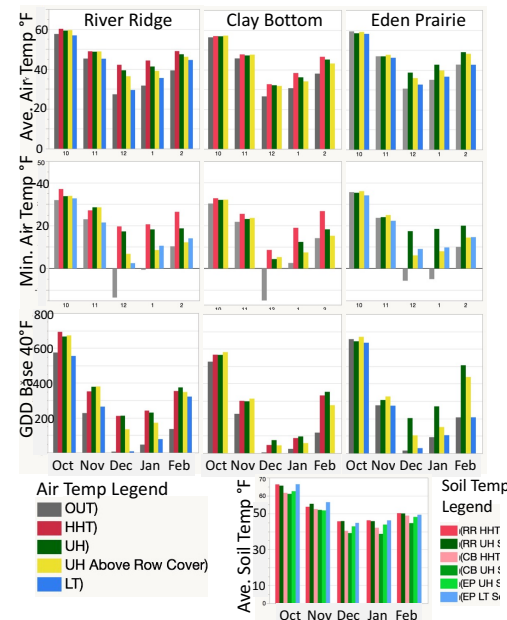
Heated and low tunnel plantings were not replicated. Heated tunnel thermostats were set around 30°F.

Spinach variety Gazelle was direct seeded on beds 24-36 inches wide with rows spaced 4-6 inches apart (Fig. 1).

Stand count 2-3 weeks after seeding and harvest data were taken from designated 4-5 sq.ft. area in each treatment plot. Individual leaves of marketable size harvested 1 to 5 times.

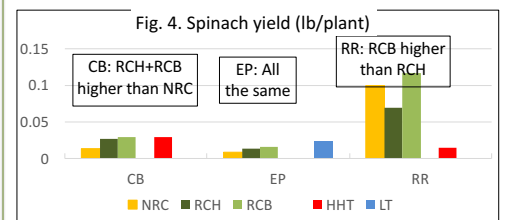
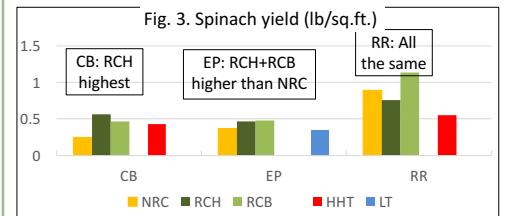
## Temperatures

Fig. 2. Monthly average and minimum air temperatures, growing degree day (base 40°F) accumulation, and average soil temperatures in structures on three farms, 2016-2017.



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## Spinach Yield Results



Results differed among the farms (Figs. 3 and 4).

At Clay Bottom, spinach in unheated tunnel under row cover with hoops yielded 18% more per square foot than under row cover blanket, and 127% more than uncovered spinach. Yield per plant was similar under row cover with or without hoops, but was 116% more with row cover than without row cover. Yield in the heated tunnel was similar to yield with row cover blanket in the unheated tunnel—a heater malfunction meant that the heater did not maintain temperature as planned (Fig. 2). Plant stand ranged from 17 to 24 per square foot in the unheated tunnel and was 29 in the heated tunnel.

At Eden Prairie, spinach in the unheated tunnel under any row cover yielded 28% more per square foot than without row cover; the difference was borderline significant. Yield per plant in unheated tunnel did not differ among row cover treatments. Yield per square foot in the low tunnel was similar to yield without row cover in the unheated tunnel. Plant stand ranged from 22 to 47 per square foot in the unheated tunnel and was 14 in the low tunnel.

At River Ridge, there was no difference in yield per square foot among the row cover treatments in the unheated tunnel. The spinach under row cover blanket had 70% greater yield per plant than the spinach under row cover with hoops; the difference was borderline significant. Yield per square foot in the heated tunnel was 59% of that in the unheated tunnel and yield per plant in the heated tunnel was 6 times less than in the unheated tunnel. Plant stand ranged from 6 to 23 per square foot in the unheated tunnel and was 18 in the heated tunnel.

Conclusions: Using a row cover on hoops or row cover resting on spinach in most cases produced similar yields. Row covers tended to increase spinach yield compared to no row covers on two farms with single-layer plastic on unheated tunnels (CB and EP). At the farm with double-layer plastic, row covers did not increase yield. Spinach did not yield more in heated tunnels than in unheated tunnels with row cover; on one farm yield was lower in the heated tunnel.

On one farm, spinach yield per unit area in a low tunnel was similar to yield in an unheated tunnel without row cover.

Overall the best method considering cost and yield was row cover laid on top of spinach in an unheated tunnel. Limitations of this study include varying plant populations, and differing soil histories in the unheated, minimally heated, and low tunnels. Also, the winter of 2016-2017 was relatively warm and row cover benefits might be greater in a colder year.