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Late-season Raspberry Production in High Tunnels: Varieties

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Introduction

Fall-bearing raspberries, also known as primocane-fruiting raspberries, are a popular option for Utah fruit producers. Cropping is not reliant on winter cane survival because they can fruit on first year canes. Canes can be cut to the ground each year to focus on a fall crop only, or can be double cropped in the fall and again in the summer by leaving canes for 2 years. Focusing only on the fall crop simplifies pruning. Because of the simplified pruning and reduced concern of winter injury, growers in the more cold, high-elevation areas of the state are interested in growing fall-bearing varieties.

However, many fall-bearing raspberry varieties fruit late in the year, and do not provide a viable crop before their production is cut off by fall freeze events. If these raspberries could be protected from early fall freezes, the production window could be further extended. High tunnels are one option of providing freeze protection to these fall crops.

Utah State University conducted two high tunnel research trials in North Logan, Utah, with fall-bearing raspberries to determine the effectiveness of high tunnel fall freeze protection. In one trial, four fall-bearing varieties (Caroline, Josephine, Joan Irene, Nantahala) were evaluated over 4 years for suitability to late-fall production in a 4-season high tunnel. This steel-frame tunnel was 30 ft x 30 ft wide and long and 17 ft tall. The plastic was left on year round with the sides left open in the summer and winter. One 27 ft row of each of the four varieties were planted inside the high tunnel, with

rows spaced 8 ft apart. The planting was established in 2010 and harvest data collection began in 2012.

'Nantahala' was released by North Carolina State University, 'Joan Irene' was released from a breeding program in the United Kingdom, and 'Josephine' and 'Caroline' were released from the University of Maryland. 'Caroline' was selected as a primocane-fruiting industry standard. 'Nantahala', 'Joan Irene' and 'Josephine' were selected for their later production season.

In a second study, 'Caroline' and 'Josephine' were planted in two replicate 2-season high tunnels (Figure 1) as well as comparison field plots. Two slightly different tunnel designs were used for the 2-season high tunnels: [\(14.5 ft wide x 10 ft tall x 40 ft long\)](#) and [\(17.5 ft wide x 9 ft tall x 44 ft long\)](#). The 2-season tunnels both had 1 row of each 'Caroline' and 'Josephine'. Rows were 42 ft long and 7 ft apart. The 2-season tunnels were only covered in the fall and early winter in an attempt provide



Figure 1. A 2-season high tunnel used for raspberry production.

freeze protection through fall freezes. The planting was established in 2010 and harvest data collection began in 2012.

In-row weed control was a combination of annual applications of pre-emergent herbicide and hand weeding. Plant nutrient needs were supplied with fertilizer applications through the irrigation system. Fertilizing was started in early June and fertilizing was conducted weekly. Over the course of the season 120 lbs N/a, 20 lbs P/a and 20 lbs K/a were applied. If the plants appeared chlorotic then a small amount of iron chelate was added to the fertilizer solution. The results of these two studies are presented here.

Production Season

4-Season Tunnel Variety Comparison

Of the four varieties planted, Caroline was the earliest to begin producing, typically hitting peak production around the end of August and quickly tapering off over the month of September. 'Joan Irene' and 'Josephine' have very similar production windows, typically hitting peak production 2 to 3 weeks after 'Caroline'. 'Nantahala' was consistently the latest variety of the four tested. Figure 2 shows the weekly yield of each variety in a representative year (2014). For reference, the first fall freeze occurred on October 22nd in 2014 year.

2-Season High Tunnel and Field Comparison

The benefit of using a high tunnel to extend the harvest window was highly variable from year to year. Season extension was achieved every year except 2015 but ranged from just 3 days to over one month (Table 1). It should be noted that fall conditions were very mild in 2015, with outdoor production continuing into November when temperatures suddenly dropped to the low 20s and cut off production both inside and outside of the

tunnels. By contrast, weather conditions in 2012 cut off both high tunnel and outdoor production relatively early (mid-October) with a hard freeze of 22 °F. The effectiveness of the high tunnel is maximized in years when the temperatures are cold enough to freeze the unprotected plants but not so cold they also shut down tunnel protection (as seen in 2013 and 2014).

Total and Late Yield

4-Season Tunnel Variety Comparison

In the 4-season tunnel, 'Caroline' had the highest total yield of the four varieties each year (Table 2). However, 'Caroline' is an early season producer and usually finished fruiting before the other three varieties, and sometimes before there was a need for frost protection, making it a less desirable choice for very late season production. Table 2 shows marketable yield for each of the four varieties after September 25, which is the long-term average first fall freeze date where they were grown. 'Nantahala' and 'Joan Irene' had the highest yields after this date of 0.67 and 0.68 pounds per linear row foot (respectively).

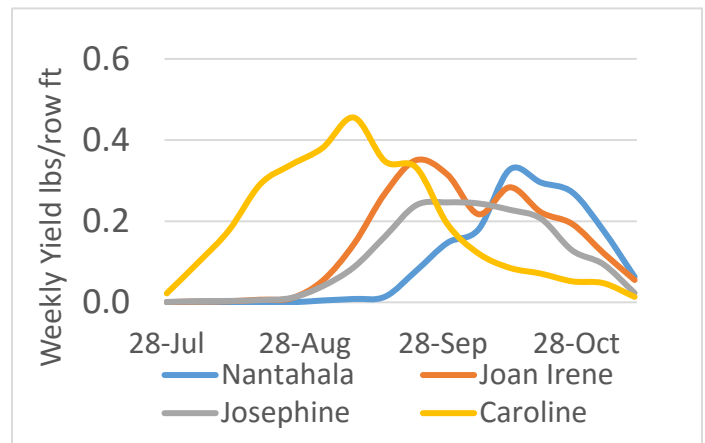


Figure 2. 2014 weekly total yield of four fall-bearing raspberry varieties planted in the 4-season high tunnel.

Table 1. Last date of harvest for the 2-season high tunnel and field-grown 'Caroline' and 'Josephine' and first freeze dates.

	HT	Field	Days Extended	< 32°F	< 27°F	< 22°F
2012	15-Oct	12-Oct	3	5-Oct	7-Oct	19-Oct
	17-	14-Oct	34	6-Oct	16-Oct	22-Nov
2013	Nov					
	13-	31-Oct	13	22-Oct	29-Oct	13-Nov
2014	Nov					
2015	6-Nov	6-Nov	0	6-Nov	7-Nov	17-Nov

Table 2. Yield parameters of four fall-bearing varieties grown in a 4-season high tunnel. Late yields were those harvested after September 25 (average first fall freeze at the Greenville Research Farm). Based on the row spacing in the tunnel, 1.5 lbs/ft is equivalent to 4.67 tons/acre.

	Total Yield (lbs/ft)			
	Nantahala	Joan Irene	Josephine	Caroline
2012	0.96	2.08	2.07	2.74
2013	0.85	0.69	0.81	2.71
2014	1.57	2.25	1.72	3.02
2015	1.24	1.26	0.02	0.01
Ave.	1.15	1.57	1.15	2.12
	Late Marketable Yield (lbs/ft)			
	Nantahala	Joan Irene	Josephine	Caroline
2012	0.19	0.22	0.21	0.07
2013	0.53	0.39	0.49	0.66
2014	1.45	1.42	1.20	0.60
2015	0.52	0.68	0.28	0.36
Ave.	0.67	0.68	0.54	0.42

2-Season High Tunnel and Field Comparison

High tunnels increased late marketable yield (after September 25th) in each year. Late yields of ‘Caroline’ in the high tunnel were an average of 0.16 lbs/ft more than the field grown ‘Caroline’. ‘Josephine’ high tunnel late yields were an average of 0.22 lbs/ft more than field grown ‘Josephine’ (Table 3).

Berry Size and Taste

Although no formal taste test was conducted, the following descriptions are based on the general opinions of the harvest crew members. Figure 3 shows pictures of fruit from each variety. ‘Nantahala’ has an orange/red color and soft fruit

somewhat dry. However, does not store more than a few days. The flavor is different from a typical raspberry but still very pleasant. ‘Joan Irene’ was the least liked of all four varieties tested. The berries were often crumbly and the thornless canes were nice to work with. They also had a high number of abnormal double flower blossoms, a symptom that is commonly associated with heat stress. ‘Josephine’ has extremely high quality, dark red berries that are the largest of all the varieties tested (Table 4). The berries have a very good flavor that seems to improve as the season progresses. Berries are quite firm and would be a good choice for individual quick freezing (IQF). ‘Caroline’ has bright red berries that are quite juicy. They are not as firm as ‘Josephine’ but pack better than ‘Nantahala’ or ‘Joan Irene’

Table 4. Average fruit size (g/fruit) in a 4-season tunnel.

Year	Nantahala	Joan Irene	Josephine	Caroline
2012	2.94	2.69	3.75	2.62
2013	3.22	3.12	3.92	2.72
2014	3.83	4.02	4.58	3.23
2015	3.17	3.15	3.96	2.80
Ave.	3.29	3.25	4.05	2.84

Summary

High tunnels were effective at prolonging the season in years when freezing temperatures halted unprotected raspberry production but were not so severe as to also stop high tunnel production. ‘Caroline’, the top producing cultivar of those trialed, is a good choice for semi-late yields as it will produce high early yields in the fall-bearing raspberry window but still continue into the late season. For the highest yield of very late production ‘Josephine’ or ‘Nantahala’ are better choices.

Table 3. Average marketable yield (lbs/ft) after September 25 comparing 2-season high tunnel to field production for ‘Caroline’ and ‘Josephine’.

	Caroline			Josephine HT	Josephine Out	Dif
	HT	Caroline Out	Dif			
2012	0.07	0.06	0.01	0.05	0.02	0.02
2013	0.79	0.45	0.34	0.45	0.16	0.28
2014	1.53	1.31	0.22	1.29	0.79	0.50
2015	0.84	0.78	0.06	0.70	0.63	0.07
Average	0.81	0.65	0.16	0.62	0.40	0.22

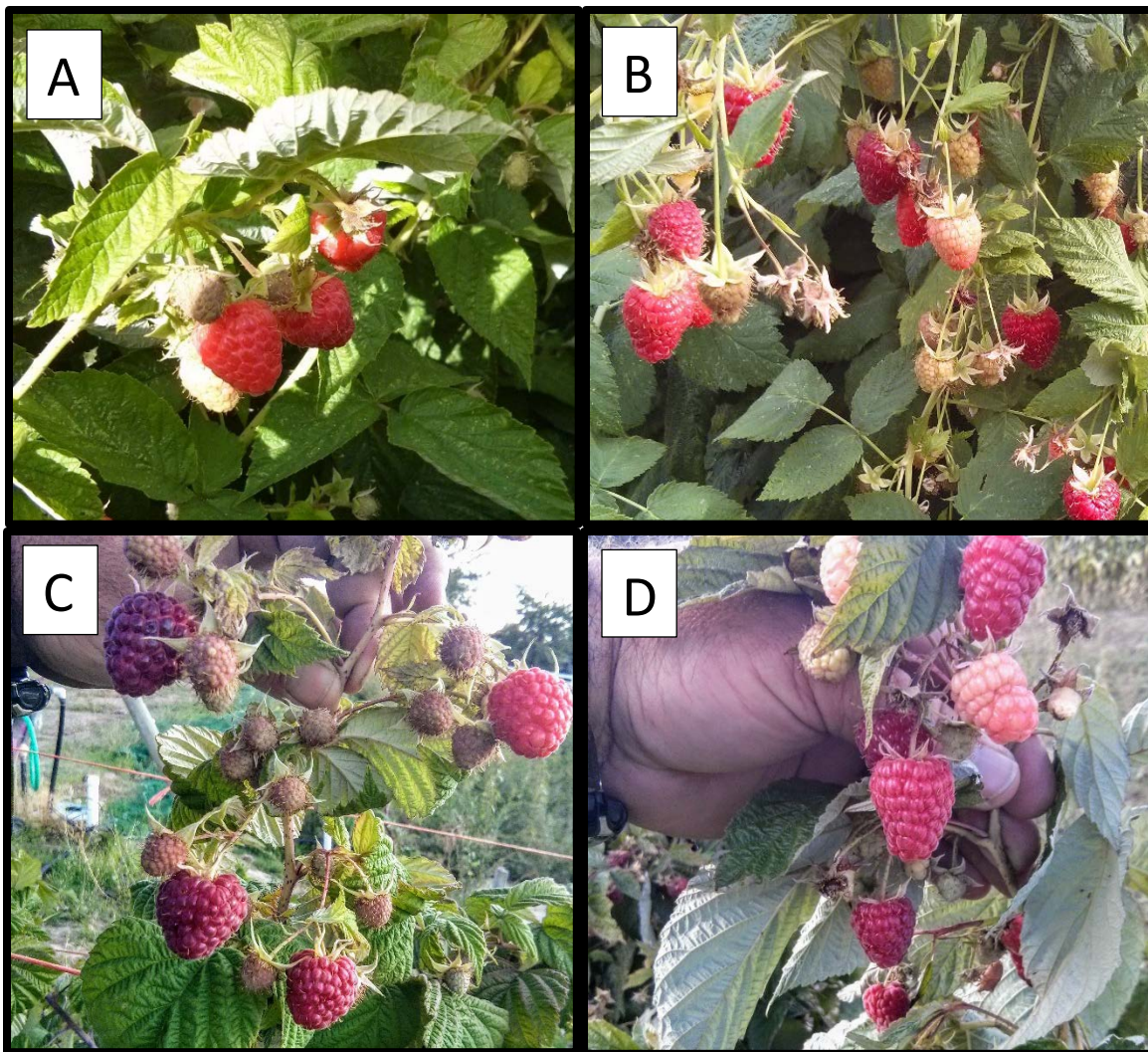


Figure 3. A: Nantahala, B: Joan Irene, C: Josephine, D: Caroline.

Additional Reading

Hanson, E., V. Morrone and R. Isaacs. 2014. Organic raspberry production in three-season high tunnels. Michigan State University. Extension Bulletin E3235. http://www.canr.msu.edu/foodsystems/uploads/files/high_tunnel_raspberry_production.pdf

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