High Tunnel Primocane Fruiting Blackberry Production in Cold Region of Midwest*

Shengrui Yao, Department of Horticulture, North Central Research and Outreach Center, University of Minnesota, Grand Rapids, MN

James J. Luby, Department of Horticulture, University of Minnesota, St. Paul, MN

A. Project summary

For the first season of this high tunnel blackberry project, primocane fruiting blackberries were planted in the south tunnel and in a field trial at the North Central Research and Outreach Center (NCROC) at Grand Rapids, MN. The cultivar/selections tested were Prime Jan, Prime Jim, MNPF1001, MNPF1002, APF41, APF45 and APF48. Additionally, three thornless primocane fruiting blackberry selections, APF136, APF138 and APF139, were planted for demonstration purposes only. Blackberries were planted in the high tunnel on May 14 and in the field on May 22. In general, blackberries grew well in 2009. We used fertigation to supply nitrogen and boron in the high tunnel, but the fertigation method caused a toxic concentration of boron near the plants. Plants showed symptoms of boron toxicity with weekly amounts of 9 g Solubor applied in the 21x48 ft high tunnel for 6 weeks. Based on this experience, the best way to supply boron fertilizer is to use a preplant application or side dressing. Be cautious with boron fertigation.

B. Project description

Blackberry production is not very common in Minnesota. There are a few small-scale floricane blackberry growers but no primocane fruiting (fall) blackberry producers in Minnesota. Delicious, locally-grown blackberries could be a nice alternative crop for the local farmers markets and local stores. However, most floricane fruiting blackberry plants are not hardy enough for the Midwest, especially for the extreme cold winter temperatures of northern Minnesota.

In 2008, we planted primocane fruiting raspberries in one of our NCROC high tunnels at Grand Rapids, and the project was very successful, resulting in the production of 154 pounds of berries from our 21 x 48 ft high tunnel in the first year. In 2005-2006, we grew primocane fruiting blackberries at NCROC, but no berries matured in 2006 due to the early frost. All the plants were killed after the winter of 2006/2007 during which there was no snow cover. Inspired by our successful raspberry experiment and mindful of our unsuccessful experience with field primocane fruiting blackberries, we thought it might be possible to try blackberries in the high tunnel. The high tunnel could extend the season for several weeks in the fall to allow the fruit to mature, and the warmer environment of the high tunnel in winter could protect the plants from winter damage. The goal of this project is to produce primocane fruiting blackberries in high tunnels in northern Minnesota.

Compared with fall raspberries, the commercial cultivars for fall blackberries are very limited, with only Prime Jan and Prime Jim available from University of Arkansas. Blackberry breeders Dr. John Clark from the University of Arkansas and Dr. Jim Luby from the University of Minnesota agreed that I could test some of their potential primocane fruiting blackberry selections.

The south high tunnel was used for this blackberry project, with an identical layout planted in the field. This high tunnel had been used to grow tomatoes, peppers and lettuce in 2007 and a cover crop of Sudan grass in 2008. Soil samples were taken in March, 2009, and the site was tilled thoroughly before planting (Figure 1). In the tunnel, one half of the recommended nitrogen (30 lb N/acre of $Ca(NO_3)_2$) was

*The author would like to thank Pat Johnson and Keith Mann for their technical support at NCROC.

applied before planting, with the rest to be added by fertigation. Blackberry plants of Prime Jan, Prime Jim, APF41, APF45, and APF48 were received as small potted plants from Dr. John Clark, University of Arkansas, and plants of MNPF1001 and MNPF1002 were received as potted selections from Dr. Jim Luby, University of Minnesota. Plants were transplanted to the high tunnel on May 14, 2009 at a spacing of 2 feet within rows and 7feet between rows (Table 1). Two T-tapes for irrigation were installed for each row in the high tunnel, and one T-tape was installed for each row of the field planting. The rest of the nitrogen (30 lb N/acre of $Ca(NO_3)_2$) for the high tunnel was added as weekly fertigation with $Ca(NO_3)_2$. Based on the soil sample results, Solubor (boron) was added at 9g per week in the fertigation solution for 6 weeks. However, the proximity of the T-tape irrigation to the plant roots caused boron toxicity in 2009. In the field, fertilizer ($Ca(NO_3)_2$ at 60 lb N/acre as recommended) was applied before planting, and plants were transplanted on May 22, 2009. Plants were watered approximately twice per week in the tunnel, based on soil moisture readings, and the field planting was watered as necessary.

In 2009, we measured plant growth, recorded temperatures inside the high tunnels and outside, and documented fertilizer and pesticide costs. We also sampled leaves for nutrient analysis in August 2009. A limited number of flowers and fruits were noted, but not enough fruit for harvesting was available. The goal of the first planting year was to allow the blackberry plants to become well established. We are expecting a successful crop in 2010.

Table 1. Blackberry Planting Map in the NCROC South High Tunnel

					North				
	1-8	**Prime Jan**	**3***	2-8	**APF-45**	**2**	3-8	**MNPF1001**	**3**
	1-7	**APF-48**	**3**	2-7	**Prime Jim**	**3**	3-7	**MNPF1002**	**2**
West	1-6	**MNPF1001**	**3**	2-6	**APF-41**	**3**	3-6	**Prime Jan**	**3**
	1-5	**APF-45**	**3**	2-5	**Prime Jan**	**3**	3-5	**APF-41**	**3**
	1-4	**Prime Jim**	**3**	2-4	**MNPF1002**	**2**	3-4	**APF-45**	**3**
	1-3	**APF-41**	**3**	2-3	**MNPF1001**	**3**	3-3	**APF-48**	**3**
	1-2	**MNPF1002**	**2**	2-2	**APF-48**	**3**	3-2	**Prime Jim**	**3**
	1-1	**APF-136**	**2**	2-1	**APF-138**	**2**	3-1	**APF-139**	**2**
					South				
	*Refers to the plant number for that cultivar/selection.								

C. Results

Blackberry plants grew well both in the high tunnel and in the field in 2009 (Figure 2). Plants were much bigger in the high tunnel than in the field; but due to the boron toxicity, the tips of some young canes showed damage with cupping leaves, burned leaf edges or dead shoot tips. Some selections were more tolerant than others. Tables 2 and 3 show the plant growth measurements in the high tunnel, and Table 4 shows the leaf nutrient analyses for both high tunnel and field blackberry plants. The nitrogen level was quite high for plants in the high tunnel; therefore, the nitrogen application should be reduced in 2010. Figure 3 was the high tunnel temperature changes during the growing season of 2009.

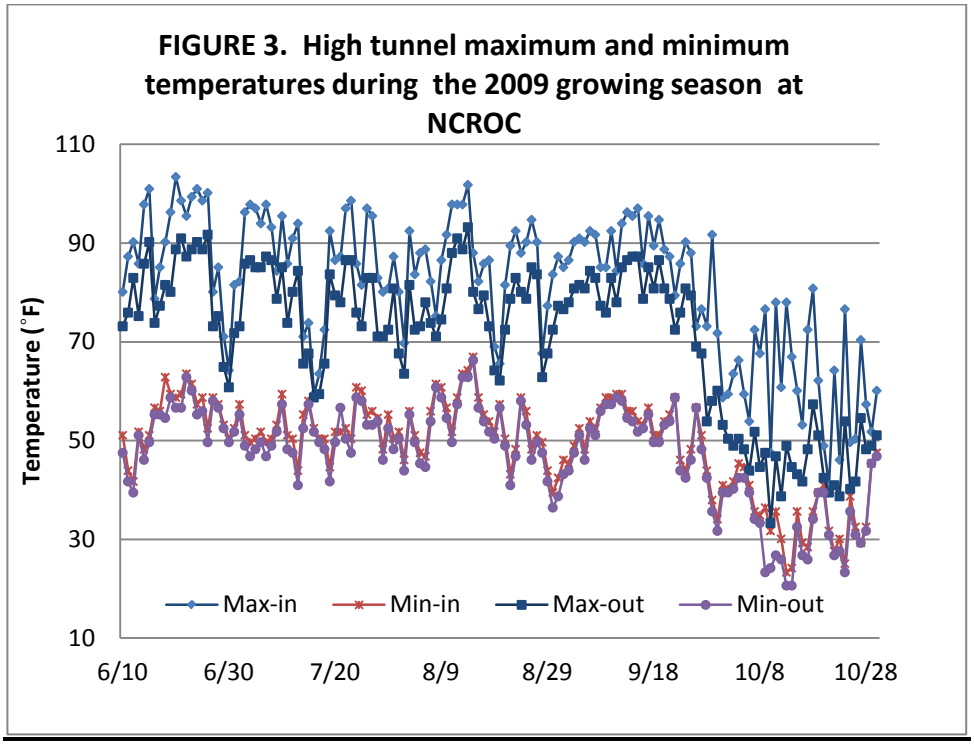
Before planting After planting

Figure 1. NOROC high tunnel before and after blackberry planting, 2009.

Field blackberries (9/18/09) High tunnel blackberries (9/18/09)

Boron toxicity (08/24/2009) Boron toxicity (08/24/2009)

Figure 2. Blackberries in the high tunnel and in the field during the growing season and the symptoms of boron toxicity in the high tunnel at NCROC, 2009.



In 2009, there were no significant pest or disease challenges, either in the high tunnel or in the field. Dr. Jim Luby told us that the plants were infested with spider mites during the propagation period in the greenhouse and that they were treated with predator mites repeatedly. All plants were healthy at planting. There might have been some leftover predator mites on the plants, and we did release 1000 predator mites, which remained from our raspberry high tunnel project.

Table 2. High Tunnel Blackberry Plant Height & Spread (in) at Grand Rapids, MN 2009

	Height (in)				Spread (in)			
Cultivars:	**30-Jun**	**21-Jul**	**21-Aug**	**23-Sep**	**30-Jun**	**21-Jul**	**21-Aug**	**23-Sep**
APF-41	6.8 b	12.8 b	21.1 b	26.8 b	10.9 bcd	20.8 ab	33.5 ab	47.8 a
APF-45	9.3 a	15.9 a	26.7 a	32.0 a	13.9 a	24.2 ab	35.9 ab	45.1 a
APF-48	7.3 b	11.1 bc	13.1 d	16.0 d	11.2 bcd	19.1 bc	25.0 cd	24.6 c
MNPF1001	7.0 b	10.8 bc	15.8 cd	17.7 cd	12.4 ab	16.0 c	27.8 bc	33.0 bc
MNPF1002	4.8 c	9.0 c	15.6 cd	17.9 cd	9.9 cd	14.6 c	20.6 d	23.4 c
Prime Jan	7.9 ab	12.3 a	19.2 bc	21.8 c	12.0 abc	21.6 ab	32.9 ab	41.8 ab
Prime Jim	7.1 b	10.9 bc	17.8 bc	18.7 cd	9.2 d	15.2 c	23.8 cd	32.1 c
Rows:								
Row 1	7.3 a	11.2 b	17.3 b	19.5 b	10.7 b	16.6 b	26.3 b	32.4 a
Row 2	6.8 a	11.3 b	18.1 ab	21.6 ab	11.3 ab	18.6 ab	28.6 ab	35.8 a
Row 3	7.5 a	13.0 a	20.0 a	23.5 a	12.1 ab	21.0 ab	30.6 ab	38.1 a

One problem that we did encounter was physiological in nature. We noticed symptoms of boron toxicity due to the Solubor used in the fertigation mixture and stopped adding it when we observed the severity of the symptoms (Figure 2). Later, part of the new growth recovered, and we hope that new

suckers will show no symptoms next year. At the same time, the raspberry high tunnel was fertigated at the same rate but without noticeable symptoms. The possible reasons could be 1)the raspberry tunnel had four rows of plants which diluted the Solubor more than the 3 rows of blackberries; 2) the second year raspberries had more biomass than the first year blackberries which could have diluted the boron below the toxic level. We would be cautious about recommended boron amounts and using boron in fertigation, based on this experience.

Table 3. NCROC High Tunnel Blackberry Branching

	Branches (average #)			
Cultivars:	**30-Jun**	**21-Jul**	**21-Aug**	**23-Sep**
APF-41	1.6 ab	2.2 a	2.7 b	4.0 b
APF-45	1.6 ab	1.8 abc	4.0 a	4.8 a
APF-48	1.8 ab	1.9 abc	2.3 b	3.0 cde
MNPF1001	1.2 b	1.2 c	2.7 b	3.2 cde
MNPF1002	1.7 ab	1.7 abc	2.2 b	2.4 e
Prime Jan	1.2 b	2.0 abc	3.1 ab	3.7 bc
Prime Jim	1.2 b	1.6 bc	2.7 b	2.9 de
Rows:				
Row 1	1.3 a	1.9 a	2.8 ab	3.4 ab
Row 2	1.5 a	1.7 a	2.5 b	3.1 b
Row 3	1.5 a	1.7 a	3.1 a	3.7 a

Table 4. Foliar Mineral Nutrient Analyses for NCROC and Elm Tree Farm - August 2009

Cultivar	N (%)	P (%)	K (%)	Ca (%)	Mg (%)	Mn (ppm)	B (ppm)	Cu (ppm)	Fe (ppm)	Zn (ppm)
High Tunnel										
APF-41	4.32	0.33	2.17	0.92	0.52	141.1	72.4	5.24	93.7	47.7
APF-45	3.98	0.34	2.53	0.74	0.10	123.9	55.3	5.43	88.5	36.3
APF-48	4.22	0.24	1.68	0.79	0.38	75.8	42.0	3.48	78.8	33.3
MNPF1001	4.64	0.33	1.97	0.82	0.61	88.0	55.6	5.15	95.8	43.9
MNPF1002	4.66	0.25	1.74	1.04	0.55	98.8	64.2	3.38	80.1	35.5
Prime Jan	4.27	0.31	1.78	0.74	0.51	65.7	45.4	5.92	84.2	39.0
Prime Jim	4.28	0.36	2.22	0.83	0.46	105.6	63.7	6.60	100.4	45.2
Field										
APF 41	2.92	0.20	1.09	0.70	0.35	401.0	124.2	2.87	73.3	42.5
APF-45	2.20	0.15	1.04	0.44	0.25	337.0	58.1	2.09	47.8	25.2
APF-48	2.71	0.17	1.16	0.65	0.30	200.0	94.7	1.43	83.9	38.3
MNPF1001	2.95	0.22	1.22	0.82	0.49	588.5	104.0	3.48	98.9	55.5
MNPF1002	3.20	0.22	1.51	1.00	0.48	451.3	156.0	2.49	120.5	48.0
Prime Jan	2.55	0.17	1.03	0.62	0.37	410.6	108.5	2.47	88.5	33.7
Prime Jim	2.93	0.19	1.18	0.68	0.29	224.9	76.8	3.34	64.0	39.2

Weed growth and type were monitored. In the high tunnel, the dominant species was dandelion since the tunnel was close to a poplar wind break where there were lots of dandelions. The dominant weed in the field was pigweed.

We did not harvest any berries in 2009. There were several plants that produced berries but not enough for harvesting. In comparison, our high tunnel primocane raspberries in 2008 produced well during their first season even though started with bare root plants. It seems that we need earlier and better cultivar selections than those that are currently available for primocane fruiting blackberries. We are expecting a full crop in 2010.

D. Management Tips

- Pre-pot the tissue cultured plugs or bare-root plants if they are not planted soon after receiving. (Additional time to erect the high tunnel may be needed, and plants respond better if they are pre-potted while waiting for final planting.)
- Tissue culture plants are highly recommended.
- Be cautious with boron or other micronutrient application, especially if the nutrients are applied through fertigation

E. Cooperator

- **Dr. John Clark**, professor/breeder at Department of Horticulture, University of Arkansas, Fayetteville AR 72701 Phone: 479-575-2810, Email: jrclark@uark.edu
  Dr. John Clark would provide the necessary APF blackberry selections for this project.

F. **Other resource**s

High tunnel raspberry production at NCROC [High Tunnel Research at NCROC]