High Tunnel Raspberries and Blackberries

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High tunnels have been used for years to accelerate the earliness of tomatoes and cucumbers, and to grow greens during cooler months of the year. They also have been used for berries in many parts of the world, primarily to maintain high quality after rain events. However, their utility for berries in the Northeast is only beginning to be realized (Figure 1).

> "The ability of high tunnels to extend the season, improve fruit quality coupled with the high value of raspberries and blackberries (several dollars a half-pint), make high tunnels economically viable for a portion of a grower's acreage. We suggest that high tunnels will become an increasingly important part of agriculture and berry production in the Northeast."

A high tunnel is a simple hoop house over which a single layer of plastic is applied. Metal hoops are set into upright pipes installed in the soil, so no foundation is required. In theory, the entire tunnel can be disassembled and moved without permanently impacting the site. Temperature is modified by opening up the sides and end walls of the structure. Plants are set directly into the ground. The only infrastructure is irrigation – lights and active temperature control are not used. This allows these structures to be classified as "equipment" rather than "structures" for purposes of regulation and zoning. A standard high tunnel is 30 X 96 ft., and 15 ft. tall at the peak, costing about $9,000 for materials and labor to install. Multibay tunnels are also available at less cost per unit area and can cover larger acreages (Figure 2). Their biggest drawback is that temperature is more difficult to regulate and they cannot be used for overwintering.

Extending the Raspberry and Blackberry Season

We have used two strategies to extend the season and improve the winter survival of raspberries and blackberries with high tunnels.

1. **Improve survival of tender floricane-fruiting raspberries and blackberries:** The climate in New York State is too cold to consistently overwinter thornless blackberries and some tender red and black raspberries. However, survival and spring growth is much improved if plants are overwintered under a closed high tunnel (Figure 3). Although one might expect that a high tunnel mitigates cold winter temperatures, this is not the case. Temperatures at night inside the tunnel can be just as cold, or colder, than outside temperatures. Temperatures also fluctuate more inside a tunnel than outside, and this theoretically could be detrimental to the canes.

Figure 1. Harvesting primocane-fruiting raspberries under a high tunnel in late October.

However, low and fluctuating temperatures do not seem to damage floricanes inside a tunnel. The primary advantage of a tunnel seems to be a reduction of the effects of wind during cold days and nights and the prevention of bud desiccation. Blackberries, in particular, respond well to a high tunnel environment in both winter and spring (Figures 4 and 5).

Growth of primocanes in the spring far exceeds growth outdoors. If unchecked, primocanes of both thornless blackberries and black rasp berries can exceed 10 feet in length by the end of June and 20 feet by the end of the season. Such rampant growth requires active management during the en-

Figure 2. Multibay tunnels in which plastic is stored between bays when not in use..

Figure 3. High tunnel covered for the winter with blackberries inside.

tire growing season. One cannot simply wait until the canes are dormant to prune and trellis.

As a consequence of better cane survival and growth, yield can be considerably higher inside compared to outside tunnels, and berry quality and size are significantly improved (Figure 1). Harvesting occurs earlier in tunnels as well. Because tractors do not have to operate in the tunnel, rows can be placed closer together (7 ft. between-row spacing vs. 10 – 12 ft. in open fields), further contributing to yield per acre. One negative factor that we have observed is that mite populations on raspberries are higher inside the tunnel than outside, so these have to be managed carefully to avoid outbreaks. Some growers have reported crumblier berries in tunnels with summer fruit. This is likely due to poor pollination during the early season when bee activity is less. Growers of early-flowering crops should position hives

Figure 4. Thornless blackberries in June 2009 grown in the open field.

Figure 5. Thornless blackberries in June 2009 grown inside a high tunnel

Figure 6. Adjustable trellis made of fiberglass poles and requiring little space.

Figure 7. Black raspberry plants during harvest, supported by an adjustable fiberglass trellis and monofilament.

Figure 8. Primocane-fruiting blackberries in early July in an uncovered tunnel. Tunnel will be covered later in the season.

Figure 9. Primocane-fruiting red raspberries (Heritage) at harvest in a high tunnel.

so that bee activity is adequate within the tunnel. Most significantly, since growth of canes is rapid and extensive, the large canes and subsequent crop load require a very sturdy trellis. We have been working with Trellis Growing Systems (Fort Wayne, Indiana) on a design that works well within a high tunnel because it is adequately strong, yet flexible thus allowing for the trellis angle to be adjusted to accommodate movement down the rows (Figures 6 and 7).

2. **Extending the harvest season of raspberries and blackberries into the late fall:** In our climate, the first heavy frost occurs in early October, yet fall-bearing types still have plenty of unripe fruit on their canes at that time. A high tunnel allows this fruit to continue to ripen well into November. This, together with tighter row spacings, higher percentage marketable fruit and higher yields per plant, has resulted in yields that are up to 10X higher than those in the field in some years.

Fall-fruiting raspberries have been available for 40 years, but fall-fruiting blackberries have just now become available for growers. Recently developed at the University of Arkansas, these thorny blackberries can be mowed down after harvest and will emerge from the ground the following spring (Figure 8). Both types benefit from high tunnels to extend the fall harvest. With red raspberries such as Heritage, the top 4 inches of primocane tip can be removed in June when they are about 3 feet tall. This practice delays harvest without much loss in yield, and is a technique for spreading out the fall harvest and reducing plant size (Figure 9). We are experimenting with primocane-fruiting blackberries (Prime-Jan) to determine if this same technique works for them, too. Josephine is a very high quality fall-fruiting red raspberry that is naturally late to fruit, so requires no tipping.

If a grower desires late fall fruit, then covering the tunnel can be done in late summer, allowing plants to grow "outdoors" for much of the season. Covering earlier, or growing primocane-fruiting types under continuous cover, will bring on the harvest

Table 1. Comparison of blackberry yields, fruit size and quality in 2007 between open fields and covered tunnels.

		Season length (days)	Size (g)	Yield (g/plant)	% marketable
Doyle	**Field**	12	4.30	146	42
	Tunnel	52	6.13	4,591	85
Ouachita	**Field**	44	5.33	267	30
	Tunnel	51	7.90	1,092	72
Triple Crown	**Field**	36	6.31	460	59
	Tunnel	50	9.57	5,046	86

Photo 10. Bumblebees congregate under high tunnels in the fall as the weather becomes cooler outdoors.

slightly earlier than in the open field. However, because raspberries do not like hot temperatures, the effect on early fruiting (from continuous covering) is not as great as the effect on late fruiting (from covering later in the season). Plastic can be removed in early winter after harvest is complete, or allowed to remain in place for another year. We have found that removing the plastic in early winter reduces the need for intensive management of mites the following year, and if covering is delayed until late August, reduces the need for manual venting. Bees also can find the flowers easier if the tunnel is not covered during flowering. However, if extended wet weather is expected during bloom, then it would be prudent to cover the tunnel. We have found that bumblebees can easily find raspberry flowers in a covered tunnel in the fall if the sides are rolled up (Figure 10).

We have conducted an economic analysis of primocane-fruiting red raspberries under tunnels, as well as provided data for an independent consultant. Each has concluded that there is extensive profit potential and return-on-investment, with payback occurring in three or four years after tunnel construction. Much of our data on plant performance and details on tunnel construction and management are found at http://www.fruit.cornell.edu/Berries/bramblepdf/HighTunnelProduction-2009rev.pdf.

Managing Pests, Nutrition and Water

Research at Michigan State University has shown that insect pressure (except for mites) is less under tunnels. This, coupled with less disease pressure (except for powdery mildew), makes organic production an option as well.

Stylet oil can be used as plants are emerging from dormancy to reduce mite pressure. Predatory mites also can be released shortly after activity is seen to provide some control. Excessive nitrogen fertilizer encourages mite population growth. A high tunnel also provides conditions favorable for powdery mildew. Venting the house every morning (even in cold weather) to remove stale, humid air will assist with mildew management.

Nutrition has to be managed differently under a tunnel than that in the open field. We have found that incorporating lots of compost before planting can help meet the nutritional needs of plants for several years. In tunnels covered year round, granular fertilizers are not washed into the soil with rain. Unless fertilizer is injected in to the irrigation system, sufficient levels must be made available prior to planting. Compost provides a slow release of nutrients, and along with an extended period of active root growth, reduces the need for an abundance of readily-available nutrients.

We have found that plants require less water under a tunnel than in the open field in most years. Plants under tunnel receive no rainfall, but there is also less evapotranspiration because of the covering and lack of wind.

High tunnels help ameliorate the extremes in temperature associated with the recent climate. Given the high value of raspberries and blackberries (several dollars a half-pint), the ability to extend the season, and the realized improvement in fruit quality, it makes economic sense to consider high tunnels for a portion of acreage. For us, an unanticipated advantage of tunnels is that farm workers can continue to work when the weather is inclement. All of these factors suggest that high tunnels will become an increasingly important part of agriculture and berry production in the Northeast

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