

# Black Raspberry Performance and Potential

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The proliferation of farm-direct retail outlets and farmers' markets in the Northeast has increased the demand for black raspberries for fresh consumption as well as for fruit wine production and other processing uses. The rise of regional marketing programs, such as Pride of NY and Ohio Proud, has increased the demand for locally produced black raspberries to meet labeling requirements. Black raspberry production in the Eastern U.S. has a long history but has declined due to low yielding, disease susceptible cultivars and competition from other crops. U.S. production was centered in New York in the early 1920's, but market conditions, along with production problems have reduced the eastern industry to a few hundred acres across the region. The vast majority of U.S. production today is centered in Oregon and is based on one cultivar, 'Munger', which was introduced in 1897. However, a resurgence of interest in black raspberry has occurred in the Northeast, which is well positioned for success because climatic conditions in the region are well suited for black raspberry production.

Additionally, recent research has highlighted black raspberries as an especially good source of phytochemicals and antioxidants, vitamins, minerals and fiber while being naturally low in calories, and fat free. Medical research has further fueled interest in the black raspberry for its potential health benefits (Stoner et al., 2007), and the flavor of the berries maintains the interest of consumers. Laboratory studies have shown black raspberries have extremely high levels of antioxidants, especially anthocyanins and other flavonoids (Weber et al., 2008). Tests in rats have shown reductions in cancerous tumor formation and cholesterol levels as well as possible anti-aging properties possibly due to the tremendous antioxidant capacity of black raspberries (Stoner et al., 2007). Human trials have begun with black raspberry formulations on pre-cancerous oral lesions, esophageal

TABLE 1

## Black Raspberry Cultivar Descriptions

**Allen** (Bristol x Cumberland) From New York. The medium sized fruit ripens relatively early with an attractive shiny black color with good quality. The plants are vigorous and moderately hardy.

**Black Hawk** (Quillen x Black Pearl) From Iowa. The fruit ripens early and is small and glossy with good firmness. The plants are vigorous, relatively hardy, and resistant to anthracnose but highly susceptible to *Verticillium* wilt.

**Bristol** (Watson Prolific x Honeysweet) From New York. The fruit ripens relatively early and is medium sized and firm, with excellent flavor. Plants are vigorous, high yielding and hardy. It is susceptible to anthracnose and tolerant to powdery mildew.

**Haut** [Manteo x (Bristol x Bristol)] From Maryland. It produces medium sized, firm fruit that ripens over a long period. The fruit is dark black, glossy and very attractive but soft. The plants are vigorous with good productivity.

**Huron** (Rachel x Dundee) From New York. The medium to large sized fruit is firm and glossy. Canes are vigorous, moderately hardy and moderately resistant to anthracnose.

**Jewel** [(Bristol x Dundee) x Dundee] From New York. The fruit is the largest of the black raspberries and is firm, glossy, and flavorful. Plants are vigorous, erect, hardy, and productive. This cultivar appears to be more disease resistant than others including resistance to anthracnose. Sunscald can be a problem in hot seasons.

**Mac Black** (parentage unknown) From Michigan. The medium large berries ripen 7-10 days later than most cultivars. The fruit is moderately firm and of good quality. The canes are vigorous, erect, and hardy.

**Munger** (Shaffer o.p.) From Ohio. The shiny black fruit is medium sized with good firmness and flavor. The canes are sprawling and moderately vigorous but have poor cold hardiness.

**New Logan** (unknown wild parentage) From Illinois. The fruit ripens relatively early and is medium sized with good quality. It is very productive. It is resistant to leaf curl virus but susceptible to anthracnose.

Black raspberry production in the Eastern U.S. has a long history but has declined due to low yielding, disease-susceptible cultivars and competition from other crops. However, a resurgence of interest in black raspberry production has occurred in the Northeast due to recent research which has shown black raspberries as an especially good source of phytochemicals and antioxidants, vitamins, minerals and fiber while being naturally low in calories, and fat free. The Northeast is well positioned for success because climatic conditions in the region are well suited for black raspberry production.

cancer and other cancers of the digestive tract (Kresty et al., 2006).

The goal of this project is to compare yield, fruit quality and disease resistance of commercially available black raspberry cultivars to demonstrate the potential and suitability of black raspberry production in NY, and to determine which existing cultivars are best suited for NY production.

## Materials and Methods

A replicated trial of nine commercial black raspberry cultivars was established in 2005 at Cornell University's New York State Agricultural Experiment Station, in Geneva, NY. The cultivars included 'Jewel', 'Bristol', 'Munger', 'Haut', 'Mac Black', 'Allen', 'Huron', 'Black Hawk', and 'New Logan', and are described in Table 1. Bare root plants, dormant tissue

culture plugs or fresh tissue culture plugs of each cultivar were planted in a Honeoye fine sandy loam soil with approximately 2% slope in four 12-plant replicates spaced two feet within row and 10 feet between rows. A two-wire V-trellis was installed after planting and drip irrigation was provided to supplement natural rainfall to one inch of water per week during the non-fruiting season and following harvest. Supplemental water was provided to equal two inches of water per week during fruit development through harvest. Fertilization followed standard recommendations from the Bramble Production Guide (Pritts and Handley, 1989) and weed control followed the Cornell Pest Management Guidelines. No other pest management was used to allow for observations on disease and insect pressure among the cultivars.

Total yield and average fruit weight was recorded and the percent fruit suitable for fresh market was calculated for two harvest seasons. Harvest dates were also recorded. Plant survival for each cultivar was also recorded to compare different nursery plant types used for establishment. Yield was calculated on a per plant basis and extrapolated to a total potential yield based on 2178 plants per acre at the above spacing. Pest resistance was also evaluated over the course of the first two seasons including aphid counts, ratings of virus symptoms and *Verticillium* root rot symptoms and overall vigor ratings.

## Results

Yield in 2006, the first harvest season after planting, averaged only 296 g per plant, which translates to a potential yield of 1416 lbs. per acre (Table 2) with the highest potential yield for 'Haut' of 2875 lbs. per acre. Yields in the second harvest season (2007) increased 2.75 fold to an average of 814 g per plant or 3899 lbs. per acre, topped by 'Bristol' at 5876 lbs. per acre (Table 2).

Fruit size in 2006 was considerably larger than in 2007, averaging 1.9 g in 2006 compared to 1.4 g, in 2007. 'Jewel' consistently had the largest fruit being the only cultivar that averaged over 2 g in the first two seasons (Table 3). 'Black Hawk' had the smallest fruit averaging only 1.3 and 0.7 g in the first two seasons, respectively (Table 3). Other cultivars with good size potential were 'Huron' and 'Mac Black'.

The harvest season ran from July 3 to July 28 in 2006 and from July 2 to July 30 in 2007. 'Black Hawk', 'New Logan' and

**TABLE 2**

**Total yield on a per plant basis and total potential yield calculated on a per acre basis for black raspberry cultivars in Geneva, NY in 2006 and 2007. The actual harvested fruit yield on a per area basis varied based on plant survival.**

Cultivar	Total Yield <sup>z</sup> (g/plant)		Total Potential Yield <sup>v</sup> (lb/acre)		% Fresh Market	
	2006	2007	2006	2007	2006	2007
Haut	600	910	2875	4361	55	63
Jewel	483	915	2314	4385	51	55
Huron	336	860	608	4121	39	67
Allen	258	729	1238	3494	46	59
Mac Black	252	865	1207	146	48	70
Bristol	251	1226	1201	5876	42	73
Black Hawk	231	432	1105	2070	35	58
New Logan	193	1103	926	5283	43	67
Munger	56	283	269	1356	49	60
<b>Annual Mean</b>	<b>296</b>	<b>814</b>	<b>1416</b>	<b>3899</b>	<b>45</b>	<b>64</b>

<sup>z</sup> Calculated as total harvested fruit divided by number of plants surviving in each harvest season.

<sup>v</sup> Calculated based on a total possible plant density of 2178 plants per acre in a planting at 2 feet within row spacing with 10 foot row center spacing. 1000 g=2.2 lb.

'Allen' had the highest early yield closely followed by 'Bristol'. 'Mac Black' was clearly the latest cultivar, with harvest beginning up to 14 days after 'Black Hawk', 'Allen' and other early cultivars and continuing 10 days after 'Jewel' and 'Haut' (Table 4).

Plant establishment and survival over two seasons varied considerably depending on the type of plant used to establish the plots. The fresh, green tissue culture plugs showed the best establishment averaging 84% survival (Table 5). Bare root plants were the most variable ranging from only 35% survival to 88% survival. Dormant, over-wintered tissue culture plugs did not establish well, with only about 50% survival after two seasons (Table 5).

Differences in disease ratings, insect counts and vigor were seen among the varieties. 'Jewel', 'Mac Black' and 'Haut' had the highest vigor and low incidence of *Verticillium* wilt after two seasons. 'Black Hawk' initially had good establishment but declined rapidly due to *Verticillium* infection. 'Allen' did not established well as a result of relatively poor planting stock. However, the plants that did survive were vigorous and healthy. 'Munger' had very good establishment and survival but exhibited extensive winter damage, which accounts for the low yields. Aphid counts were relatively low with only about five aphids per shoot in the most infested plots. 'Huron', 'Allen' and 'Munger' had the lowest aphid counts with an average of 1.5 aphids per shoot. Virus symptoms were not readily apparent after two seasons and will continue to be monitored in future seasons.

**TABLE 3**

**Average fruit weight in 2006 and 2007 for nine black raspberry cultivars at Geneva, NY.**

Cultivar	Mean Fruit Weight <sup>x</sup> (g)	
	2006	2007
Jewel	2.7	2.1
Mac Black	2.4	1.5
Huron	2.2	1.8
Haut	1.9	1.6
Allen	1.8	1.4
Munger	1.7	1.2
New Logan	1.7	1.3
Bristol	1.7	1.4
Black Hawk	1.3	0.7
<b>Annual Mean</b>	<b>1.9</b>	<b>1.4</b>

<sup>x</sup> Mean weights calculated from three 20 fruit samples taken during the harvest season.

## Discussion

Black raspberries (*Rubus occidentalis*) have the potential to be a profitable crop for growers in the North Central and Northeastern states in a diversified farm. They are a high value crop with a gross revenue potential of over \$13,000 per acre in peak production seasons at wholesale prices. However, establishment costs are high and budget projections indicate the breakeven point to come in the second production season, some 26 months after planting (Pritts and Handley, 1989). Black raspberry must bring a premium price compared to red raspberry to be a viable crop for most growers due to low yields and small fruit. Our experience indicates that such prices are realistic in the current supply/demand situation. However, data from the Oregon black

raspberry industry indicates that it is possible for production to outstrip demand, thus erasing the needed price premium.

Productivity of currently available cultivars can begin to decline after two production seasons due to pest pressure. Typical yields in the region range from one to three tons per acre compared to three to seven tons per acre for red raspberry, with fruit size generally less than 2.5 grams per berry. Fruit size can be especially small in dry years like 2007, even with supplemental irrigation. However, the eating quality still remains high in most cultivars. Additionally, proper pest management is critical to ensure a high percentage of fresh market fruit. Without fungicides, losses of 30% or more can be expected from fruit rots. Sunscald can also present a problem especially in hot years such as 2007, which accounted for the low percentage of fresh market fruit from 'Jewel'. In 2006, most fruit that was not marketable fresh was due to the sprawling first year growth producing fruit close to the ground combined with soil splashing from numerous rainfall events. Planting a series of varieties such as 'New Logan', 'Bristol', 'Jewel' and 'Mac Black' will provide the longest possible season with high fruit quality.

Obtaining high quality planting stock is another important step in developing a successful black raspberry planting. Poor plant material guarantees a poor planting, which accounted for the poor establishment of 'Allen', 'Bristol' and 'Huron'. Plants should be ordered from a reputable source, preferably a nursery that sells plants from "certified" virus-free stock. Certification is an assurance that the plants have been tested and found free of common viruses. Virus-free plants have the best growth and productivity and will generally live longer and be profitable. Tissue culture plug plants are most likely to be virus free and establish well as seen with 'Jewel' and 'Munger'. Bare-root nursery stock has a greater chance of being infected with disease than plants grown from tissue culture and can be variable in quality.

Two major diseases contributed to the stagnation of black raspberry production in the Northeastern U.S. in recent years due in large part to low yields and short planting life (commonly referred to as "Raspberry run-out"). Wilt, caused by the fungus *Verticillium albo-*

**TABLE 4**

**Harvest dates for nine black raspberry cultivars in 2006 and 2007 at Geneva, NY.**

Cultivar	First Harvest		50% Harvest		Final Harvest	
	2006	2007	2006	2007	2006	2007
Black Hawk	July 3	July 2	July 11	July 5	July 21	July 12
New Logan	July 3	July 2	July 11	July 6	July 17	July 17
Bristol	July 5	July 2	July 11	July 6	July 21	July 17
Allen	July 3	July 2	July 11	July 10	July 24	July 17
Haut	July 5	July 2	July 11	July 11	July 26	July 20
Munger	July 5	July 2	July 14	July 13	July 21	July 17
Jewel	July 7	July 6	July 11	July 13	July 26	July 20
Huron	July 7	July 9	July 11	July 12	July 26	July 17
Mac Black	July 14	July 16	July 19	July 23	July 28	July 30

*atrum*, and the Raspberry Mosaic Disease Complex, caused by Blackberry Necrosis, Rubus Yellow Net and/or Raspberry Leaf Spot-like viruses, are significant impediments to long term productivity of plantings.

Verticillium or bluestem wilt reduces yields by wilting, stunting, and eventually killing fruiting canes or entire plants. It is prevalent in poorly drained soils and is especially problematic following cool, wet springs that are common in the Northeastern U.S. This disease cannot be controlled through chemical practices, but can be reduced or avoided through planting clean stock in well-drained soil. Furthermore, once established, *Verticillium* has the ability to persist in soils for long periods. The best means for control is through genetic resistance, which is variable among commercial cultivars with 'Black Hawk' being especially susceptible. Vigorous cultivars such as 'Jewel', 'Mac Black' and 'Haut' seem to tolerate the disease better than others.

Raspberry mosaic disease complex, associated with the 3 viruses mentioned above, causes great reduction in growth, vigor, and fruit yield through a progressive reduction of vigor over the life of the planting. This disease is spread by the large raspberry aphid (*Amphorophora*

*agathonica*) and possibly by the black raspberry aphid (*Amphorophora sensorata*). Avoidance of the mosaic disease complex in red raspberry (*Rubus idaeus*) is commonly achieved through resistance to aphid colonization. However, viral symptoms have not been apparent in this planting to date.

Further evaluations of these cultivars will be completed in coming seasons to evaluate continuing productivity and disease pressure. Further research into high tunnel production and breeding for increased fruit size, productivity and disease resistance will also provide growers greater options for producing this delicious and nutritious berry.

### Literature Cited

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**TABLE 5**

**Plot establishment and survival of nine black raspberry cultivars over two seasons at Geneva, NY.**

Cultivar	Nursery plant type	Percent Survival
Huron	dormant tissue culture plugs	48
Bristol	dormant tissue culture plugs	54
Jewel	green tissue culture plugs	79
Munger	green tissue culture plugs	88
Allen	bare root canes	35
New Logan	bare root canes	50
Black Hawk	bare root canes	65
Haut	bare root canes	88
Mac Black	bare root canes	83

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