Journal of the American Pomological Society 75(4): 182-188 2021

# Evaluation of Five Primocane-fruiting Red Raspberry Cultivars in Grow Bags Under Protected Culture in Southern Missouri

Marilyn B. Odneal[1], Jennifer Morgathaler[2], Dr. William McClain[3]

**Additional index words:** container, *Rubus idaeus,* yield


## Abstract

Five primocane-fruiting red raspberry (*Rubus idaeus* L.) cultivars ('Crimson Giant', 'Himbo Top', 'Joan J', 'Josephine' and 'Polka') were grown in protected culture in 19 L grow bags in southern Missouri. Raspberries were cropped in a single-bay high tunnel, pruned, rotated outdoors and protected with straw mulch to overwinter. Marketable yield and fruit weights were recorded from 2014 (establishment year 0) through 2019 (year 5). 'Joan J' produced the highest yield in the establishment year of 744 g/plant. 'Himbo Top' and 'Joan J' produced the highest yield overall with year 1 – 3 means of 1626 and 1614 g/plant respectively. All cultivars produced a commercially acceptable yield in years 1 - 3. There was a crop failure in year 4 and yield declined in year 5. 'Crimson Giant' had the largest fruits based on a three-year mean (4.16 g), significantly different from 'Josephine' (3.51 g), 'Joan J' (3.46 g), 'Polka' (3.18 g) and 'Himbo Top' (3.12 g).


All raspberry cultivars can produce fruit on second year floricanes, but many also produce on current season primocanes. Primocane-fruiting cultivars may be managed solely for the primocane crop or for both the primocane and floricane crops.

The United States is the third largest raspberry producer in the world (Shahbandeh, 2019). Most fresh market raspberries for the Eastern U. S. are produced in California and Mexico, requiring long-distance shipping to market (Weber, 2010). Growers in the United States are using multi-bay and single-bay high tunnels for red raspberry production (Demchak, 2009). High tunnels are used by relatively small-scale producers to serve local markets in states other than California (Carey et al., 2009). Primocane-fruiting raspberry production in high tunnels exhibited increased yield and fruit size, extension of the growing season and improved fruit quality when compared to field plantings (Both, et al., 2019; Conner and Demchak, 2018; Demchak et al., 2017; Demchack, 2009). High tunnels provide the added benefit of allowing year-round and inclement weather work to be conducted (Carey, 2009) and improved harvest efficiency through concentrated fruit density, larger fruit size, and low cull rates (Weber, 2010).

Field grown raspberries have not proven to be a viable commercial crop in Missouri, but primocane-fruiting raspberries grown in protected culture have commercial potential in this region. Heavy soils, poor internal water drainage and hot and humid summers often limit primocane fruiting raspberry production in the field in Missouri. The University of Arkansas reported successful high tunnel primocane-fruiting raspberry research trials (Rom, et al., 2015). Compared to an adjacent field planting, yield, fruit weight, plant size and fruit quality were superior in high tunnels at the Missouri

[1] Corresponding author email address: MarilynOdneal@missouristate.edu State Fruit Experiment Station, Missouri State University, 9740 Red Spring Road, Mtn. Grove, MO 65711

[2] Clinical Instructor and Former Graduate Student, Environmental Plant Science and Natural Resources, Missouri State University

[3] Assistant Professor and Graduate Advisor, Environmental Plant Science and Natural Resources, Missouri State University

State – Mountain Grove High Tunnel Demonstration. However, the in-ground raspberries declined in this demonstration due to poor internal water drainage and possible root rot complications in the rows located adjacent to the tunnel side-curtains (Odneal and Wilker, 2015).

High tunnel production of raspberries offers growers an opportunity to produce a high value crop for local markets. Container culture of primocane-fruiting raspberries in protected culture was successfully used to compare new cultivars for production and quality traits (Hanson, et al., 2018). Primocane-fruiting raspberries are easily manipulated to extend the season in tunnels (Pritts, 2008) and the mobility of container culture allows other high tunnel crops to be grown when the raspberries are not producing. Container culture avoids soil-related problems including unsuitable soil, poor internal water drainage, and soil-borne pathogens. Although containerized raspberries include additional costs compared to in-ground plantings, rotation of other crops in the same space offers the advantage of generating additional revenue from that space.

Much of the research on raspberry production in the Eastern U. S. has been done in in regions above 40 degrees north latitude (Demchak et al., 2017; Hanson et al., 2018; and Weber, 2018). The purpose of this trial was to assess the performance of five primocane-fruiting red raspberry cultivars in grow bags (primocane crop only) placed in a high tunnel from May to early Dec. and then rotated outdoors after pruning from mid-Dec. through early spring in south-central Missouri. Raspberries in container culture allows other crops, such as lettuce, to be grown in the tunnel when raspberries have been moved out. This system could allow growers to test primocane-fruiting raspberries in their operations without exclusively dedicating high value tunnel space.

## Materials and Methods

The trial was conducted in a 9.14 X 29.3 X 2.44 m (W X L X H) high tunnel (Morgan County Seeds, Zimmerman steel frame Barnett, MO) oriented east/west with double poly greenhouse film (Dura-Film Super4, RPC bpi Agriculture, Edmonton, Canada) at the Missouri State Fruit Experiment Station in Mountain Grove (lat. 37˚9'N, long. 92˚15'W, 480 m elevation). Thermostatically controlled side curtains were open most of the season but were programmed to close at 16˚ C later in the season when the weather was cooler. The five cultivars (treatments) of primocane-fruiting red raspberries included 'Crimson Giant', 'Himbo Top', 'Joan J', 'Josephine', and 'Polka'. 'Crimson Giant' (Cornell University-NYSAES) is a large fruited, late-fruiting cultivar suitable for greenhouse and high tunnel production (Weber, 2012; Weber, n. d.). 'Himbo Top' (Rafzaqu in Switzerland) produces bright red fruit with good flavor. Plants are vigorous with very long fruiting laterals (Weber, 2012). 'Joan J' (Great Britain) is an early season cultivar with dark red fruit and spineless canes (Weber, 2012). 'Josephine' (University of Maryland) is a late season cultivar with firm, cohesive berries on upright, vigorous plants (Weber, 2012). 'Josephine' was chosen as the standard of comparison since it performed well in an in-ground observational trial of primocane-fruiting raspberries in the high tunnel at Mountain Grove (Odneal and Wilker, 2015). 'Polka' (Poland) has medium-large fruit and ripens in the mid-fall season. Potato leaf hoppers prefer this cultivar and may cause significant damage (Weber, 2012). 'Himbo Top' (Nourse, South Deerfield, MA), 'Josephine' (Nourse, South Deerfield, MA), 'Polka' (Nourse, South Deerfield, MA) and 'Joan J' (Stark Bros., Louisiana, MO) were obtained as dormant bareroot stock and planted 22 April 2014. 'Crimson Giant' (North American Plants, Inc., McMinnville, OR) was obtained as a plug and planted 21 May 2014. Raspberries were planted in 19 L grow bags (Root Control Bag Pro #5, High

Caliper Growing Systems, Oklahoma City, OK) with 15 L of Fafard 52 media (Sun Gro Horticulture, Agawam, MA) containing 50–55% composted pine bark, Canadian sphagnum peat moss, perlite, dolomitic limestone (pH adjuster for soilless mix) and a wetting agent. Media was added to the bags in Dec. 2017 to bring the level back up to 15 L. Irrigation was applied via one 12.1 Lph fan pressure compensating spray stake per bag and ran 2-10 minutes, 2 times daily (variation through season). Moisture status was assessed using the "feel" method on media in the bags at representative parts of the planting and irrigation duration was adjusted accordingly. Nitrogen was applied at each watering at 100 ppm using Peters Excel B 21N-2.0P-16.6K with B, Cu, Fe, Mn, Mo and Zn (JR Peters Inc., Allentown, PA). Foliar samples were collected and analyzed during Aug. from 'Josephine' and 'Crimson Giant' cultivars to track nutrient status in 2015 and 2016 under this fertilizer regime. Nutrients were in the sufficiency range (Bushway et. al, 2008) except for sulfur which was low. A three-wire "V" raspberry trellis was installed (TGS Trellis Growing Systems, Fort Wayne, IN). The two rows were spaced 2.44 m apart. The cultivars (treatments) were arranged in the high tunnel in a randomized complete block design (RCBD) in 5-plant (bag) replications in 4 blocks in two rows running east and west in the southern half of the tunnel. Blocks were arranged inner row west, inner row east, outer row west and outer row east. Raspberries were grown, harvested, pruned and overwintered for 6 years. All raspberry bags (5 per replication, 20 per treatment) were harvested Monday, Wednesday and Friday in the tunnel from June through Nov./early Dec. and then rotated outside after pruning in mid to late Dec. Killing fall freezes (-2.2 C or lower) occurred outside of the high tunnel on 1 Nov. 2014 (-5.7 C), 21 Nov. 2015 (-6.4 C), 19 Nov. 2016 (-2.8 C), 28 Oct. 2017 (-4.7 C), 9 Nov. 2018 (-5.2 C) and 31 Oct. 2019 (-2.6 C). The bags were lined up tightly outdoors in 4 rows on a level area next to the tunnel with square straw bales set along the perimeter and with 15 to 20 cm of loose straw spread over the tops of the bags. Straw was removed when new growth was observed in late winter or early spring of the following year and bags were then fertilized with 15 ml 14N-6.1P-11.6K Osmocote (The Scotts Company, Marysville, OH). Shoots were thinned to 4 to 5 per bag (per 30.5 cm) and rotated into the tunnel in mid-May. Additional new basal canes, lower leaves up to 30.5 cm, and low-lying lateral branches were removed two to three times during the season.

Data collected during harvest included marketable yield and average fruit weight based on a 25-fruit sample (or less if 25 fruit were not available). Cull yield was not measured but collected and removed from the planting to help manage Spotted Wing Drosophila (SWD, *Drosophila suzukii*). Raspberries were sprayed weekly for SWD on Mondays after dark to avoid contacting pollinators that were active during the day. Cull fruit were collected and put in salt-water (237 ml salt per 3.79 L water) to check for larvae and assess the effectiveness of pesticide application. Shade cloth (50%) was used to shade plants in July and Aug. and applied when white drupelets were noticed. Cool, wet weather along with the additional shade promoted Botrytis (*Botrytis cinerea*) which was noted on 15 July 2016 and 11 Aug. 2017 and then treated with fungicide. An interior, moveable shading system was constructed in 2018 that could be retracted during overcast or cooler weather in the summer to alleviate this problem. Pollination was adequate from 2014 through 2017 by leaving the high tunnel sides open and allowing pollinators to access the plants. In 2018, crop failure occurred. No pollinators were observed in the high tunnel or the surrounding area throughout the 2018 harvest season. However, plants grew normally in spring, 2019. One Natupol Excel bumble bee box (Koppert Biological Systems https://www.koppertus.com/) was set at the end of the tunnel and replaced at

intervals during blossoming in 2019 and yield rebounded. Mites were observed again in 2019 and were managed with insecticidal soap.

The High Caliper grow bags held their integrity throughout this period and were successfully overwintered even after the last harvest in 2019 with healthy shoots noted in spring 2020. Some roots grew through the bag and into the soil below, but bags were easy to move despite this and the bag integrity was not compromised by root growth. No circling roots were observed when plants were removed from the bags in 2020. It was estimated by the manufacturer that the bags would stand up for 10 years in this system (personal communication Steve McCurdy, High Caliper Growing, Inc., 2014). Data were analyzed using NCSS 11 Data Analysis Software Package using One-Way ANOVA with block as a random effect. Significant differences in means were determined using the Tukey-Kramer Multiple Comparison Test.

'Crimson Giant' had the latest production season as well as the highest number of unripe fruits in Dec. when harvest was discontinued. Two plants died in 2017 and both were 'Crimson Giant' (10% mortality). 'Himbo Top' canes had more vegetative growth as noted in another trial (Weber, 2018) and the canopy was more difficult to manage. Berries were soft at times during the season which has been attributed to high temperature (Weber, 2018). 'Polka' often exhibited a leaf curling and discoloration symptom, not usually observed on the other cultivars in the trial. The cause of this problem was not determined.

## Results and Discussion

Two 'Crimson Giant' plants died in block 2. Mean yield was based on 18 plants instead of 20 (Table 1). This cultivar was pruned in Dec. when not as fully dormant as the other cultivars, which may have contributed to plant death. No plant mortality was observed in the other cultivars.

Harvest (Table 2) began with 'Polka' in June and July, followed by 'Joan J' (late-June to July), 'Himbo Top' (late June to mid-July), 'Josephine' (July) and 'Crimson Giant' (Aug.). All cultivars produced fruit through Nov. Peak yield occurred in July for 'Polka', July to Aug. for 'Himbo Top', Aug. for 'Joan J' and 'Josephine' and Sept. to early Nov. for 'Crimson Giant'. 'Joan J' had the longest harvest season with a mean of 156 days (years 1 – 3), followed by 'Polka' with 153 days, 'Himbo Top' with 138 days,

**Table 1.** Yields of five primocane-fruiting raspberry cultivars in grow bags under protected culture in Mountain Grove, Missouri 2014 – 2019.

| | Yield (g/plant)[z] | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Year 0[y] 2014 | | Year 1 2015 | | Year 2 2016 | | Year 3 2017 | | Year 4[x] 2018 | | Year 5 2019 | | Mean Years 1 - 3 | |
| Cultivar | | | | | | | | | | | | | | |
| Crimson Giant | 191 | c[w] | 959 | b | 829 | bc | 1895 | ab | 31[v] | c | 803[v] | a | 1228 | bc |
| Himbo Top | 461 | b | 1249 | ab | 1254 | a | 2105 | a | 246 | a | 958 | a | 1626 | a |
| Joan J | 744 | a | 1473 | ab | 1385 | ab | 1983 | ab | 156 | b | 1205 | a | 1614 | ab |
| Josephine | 484 | b | 1005 | b | 1176 | b | 1403 | bc | 54 | c | 823 | a | 1195 | c |
| Polka | 281 | c | 1287 | ab | 1054 | ab | 1233 | c | 80 | bc | 942 | a | 1191 | c |
| Annual Mean | 432 | | 1195 | | 1140 | | 1724 | | 113 | | 946 | | | |

[z] Grams per single plant in 30.5 cm diameter 19 L grow bag. Multiply by 0.00378 for kilograms per linear meter of row.
[y] Establishment year.
[x] Crop failure in 2018 due in part to inadequate pollination.
[w] Means within columns followed by common letters do not differ at the 0.05 level by Tukey-Kramer Multiple Comparison Test
[v] Two plants of 'Crimson Giant' died in 2017 so yield in 2018 and 2019 is based on 18 plants rather than 20 as in the other treatments.

**Table 2.** Harvest dates for 5 primocane-fruiting red raspberries in grow bags under protected culture over three harvest seasons in Mountain Grove, MO.

| Cultivar | Year | First Harvest Date[z] | Last Harvest Date[y] | Peak Harvest Date[x] | Season Length (days) |
|---|---|---|---|---|---|
| Crimson Giant | Year 1 | Aug 31 | Nov 30 | Nov 2 | 92 |
| | Year 2 | Aug 29 | Dec 5 | Nov 7 | 99 |
| | Year 3 | Aug 11 | Nov 27 | Sep 5 | 119 |
| Himbo Top | Year 1 | June 22 | Nov 30 | Aug 31 | 131 |
| | Year 2 | July 18 | Dec 5 | Aug 22 | 141 |
| | Year 3 | July 10 | Nov 27 | July 24 | 141 |
| Joan J | Year 1 | July 6 | Nov 30 | Aug 31 | 147 |
| | Year 2 | June 24 | Dec 1 | Aug 8 | 161 |
| | Year 3 | June 26 | Nov 27 | Aug 7 | 159 |
| Josephine | Year 1 | July 24 | Nov 30 | Aug 31 | 130 |
| | Year 2 | July 20 | Dec 5 | Aug 22 | 139 |
| | Year 3 | July 12 | Nov 27 | Aug 21 | 139 |
| Polka | Year 1 | June 15 | Nov 23 | July 20 | 162 |
| | Year 2 | July 5 | Dec 1 | July 27 | 150 |
| | Year 3 | July 3 | Nov 27 | July 24 | 148 |

[z] Date when at least 100 grams of fruit was harvested from a cultivar (four 5-bag treatments, each bag 30.5 cm in diameter)
[y] Last date when at least 100 grams of fruit was harvested from a cultivar (four 5-bag treatments, each bag 30.5 cm in diameter)
[x] Date with the highest total yield.

'Josephine' with 136 days and 'Crimson Giant' with 103 days.

Fruit yield (Table 1) was lowest in the establishment year for all cultivars except for year 4 when the crop failed. Fruit yield was best in the first three years, with highest yield in year 3. Even though there was a crop failure in year 4, yield rebounded in year 5 after pollinators were introduced. Yield in year 5 was lower for all cultivars when compared to the year 1 through 3 means. The cause for the decrease in yield in year 5 was not determined. When raspberries were removed from the bags after the last harvest, it was observed that the roots were healthy, but very dense. It is possible they would have benefited from root pruning at this point.

'Himbo Top' had the highest mean yield in years 1-3 of all cultivars in this trial. 'Joan J' was the second highest yielding cultivar, not significantly different from 'Himbo Top'. These two cultivars also performed well in another trial in grow bags in protected culture (Hanson, et al., 2018). 'Josephine' had the second lowest mean yield years 1-3. The mean yield years 1 – 3 of 'Polka' was the lowest compared to the other cultivars.

Fruit weight (Table 3) was highest based on the mean for years 1 through 3 for 'Crimson Giant' (4.16 g) which was significantly

**Table 3.** Mean fruit weights of five primocane-fruiting red raspberry cultivars in grow bags under protected culture over three harvest seasons in Mountain Grove, MO.

| Cultivar | Mean fruit weight (g) | | | |
|---|---|---|---|---|
| | Year 1 2015 | Year 2 2016 | Year 3 2017 | Years 1 - 3 |
| Crimson Giant | 4.31 a[z] | 3.80 a | 4.39 a | 4.16 a |
| Himbo Top | 3.06 b | 2.72 c | 3.57 c | 3.12 d |
| Joan J | 3.38 b | 3.15 b | 3.85 bc | 3.46 bc |
| Josephine | 3.30 b | 3.21 b | 4.03 ab | 3.51 b |
| Polka | 3.20 b | 2.91 c | 3.43 c | 3.18 cd |

[z] Means within columns followed by common letters do not differ at the 0.05 level by Tukey-Kramer Multiple Comparison Test.

different from 'Josephine' (3.51 g), 'Joan J' (3.46 g), 'Polka' (3.18 g) and 'Himbo Top' (3.12 g).

Where year 0 is the establishment year, estimated yield was calculated from the "Budget for In-Ground Single-Bay High Tunnel Fall-Fruiting Raspberry Production, NY" in the "High Tunnel Production Guide for Raspberries and Blackberries" (Both, et al., 2019) for years 1 to 10. Estimated yield of 667 g/30.5 cm per linear row for year 1, and 889 g/30.5 cm per linear row for years 2 to 10, was used to compare the yields observed in this trial. 'Joan J' in year 0 exceeded the estimated yield for year 1. All cultivars exceeded the estimates for years 1 through 3, except for 'Crimson Giant' in year 2. 'Himbo Top', 'Joan J' and 'Polka' exceeded the estimated yield for years 2 – 10 in year 5 as well.

The actual cause or causes of the crop failure in 2018 was not conclusively determined. In a trial with Cuthbert floricane fruiting red raspberries, 34 percent of raspberry flowers produce berries when insects were excluded, but 72 percent set fruit when blossoms were exposed to pollinating insects. The percent of imperfect berries when pollinators were excluded was 43% whereas only 3 percent of imperfect berries were observed on plants open to insect pollination (Johnston, 1929). Lack of pollinators was thought to be a significant factor in the 2018 crop failure, although yellow mites (*Eotetranychus carpini borealis*) were observed in 2018 and Botrytis, which was a problem in earlier years, may have also played a role.

Even though container culture is more expensive at establishment, it can avoid down-time that may need to be spent on alleviating a soil-related problem. Additional costs in container raspberry establishment may be offset by additional crops rotated into the system when raspberries are out of the tunnel.

Based on research work in Michigan, the yield of primocane-fruiting raspberry plants in-ground in high tunnels were comparable in years 2 – 4 after planting. Declining yields were observed after the 5th year in East Lansing (Eric Hanson, Michigan State University, East Lansing, MI, personal communication, 2021). In coastal California where the first primocane crop is harvested 6 to 8 months after planting, it is common for raspberry yields to decline after 3 to 5 years, despite being planted in soil or in pots. (personal communication Ellen Thompson, Hortifrut North America, Inc., Watsonville, CA, 2020).

This trial indicates that, in Missouri, growing the plants outdoors in the establishment year (Koester and Pritts, 2003) followed by a 3 to 5-year cycle of production in the high tunnel is feasible. Five seasons of production after establishment was not demonstrated in this trial due to crop failure in 2018, however, the yield rebound in 2019 indicates that 5 seasons of production after establishment is attainable in this system. The grow bags used held integrity for 6 years in this trial. If pollinators, such as bumblebees in boxes are provided, low yields due to fluctuations in pollinator populations could be avoided. Mites also need to be closely monitored and controlled. Root pruning or aeration and regular media addition may be useful tools to extend production to year 5 or beyond.

## Acknowledgements

This project was funded by the Specialty Crop Block Grant Program and the USDA. Integral support personnel included Shelia Long, Field and Maintenance Worker; and Jeremy Emery and Randy Stout, Field and Maintenance Supervisors at the Missouri State University Fruit Experiment Station, Mountain Grove.

## Literature Cited

Both, A. J., K. Demchak, E. Hanson, C. Heifereich, G. Loeb, L. McDermott, M. Pritts and C. Weber. 2019 (revised). High Tunnel Production Guide for Raspberries and Blackberries. Cornell University. 1 Dec 2020. <http://www.hort.cornell.edu/fruit/pdfs/high-tunnel-brambles.pdf>

Bushway, L., M. Pritts and D. Handley. 2008. Raspberry and Blackberry Production Guide. Coop. Ext. NRAES-35. 3 Mar 2021 <https://www.canr.msu.edu/foodsystems/uploads/files/Raspberry-and-Blackberry-Production-Guide.pdf>

Carey, E. E., L. Jett, W. J. Lamont, Jr., T. T. Nennich, M. D. Orzolek, and K. A. Williams. 2009. Horticulture crop production in high tunnels in the United States: A snapshot. HortTechnology 19(1)37-43.

Conner, D. S. and K. Demchak. 2018. Farmer perceptions of tunnels for berry production: management and marketing implications. HortTechnology 28(6)706-710.

Demchak, K., J. K. Harper and L. F. Kime. 2017. Red raspberry production. Penn State Ext. 15 Dec 2020. <https://extension.psu.edu/red-raspberry-production#section-2>

Demchak, K. 2009. Small fruit production in high tunnels. HortTechnology 19(1):44 – 49.

Hanson, E., B. Crain and D. Brown-Rytlewski. 2018. Primocane-fruiting red raspberry evaluation in high tunnels. J. Amer. Pomol. Soc. 72(2):122-127.

Johnston, S. 1929. Insects aid fruit setting of raspberry. Mich. Agr. Expt. Sta. Quart. Bul. 11(3): 105-106

Koester, K. and M. Pritts. 2003. Greenhouse raspberry production guide. Dept. of Horticulture Publication 23. Cornell University. 1 Nov 2019. <https://cpb-us-e1.wpmucdn.com/blogs.cornell.edu/dist/0/7265/files/2017/01/ghrasp-1-1jdbp2j.pdf>

Odneal, M. B. and K. Wilker. 2015. Raspberry demonstration and distillation at the Missouri State Fruit Experiment Station. Poster Presentation at the 2015 North Amer. Raspberry and Blackberry Growers Conf., Fayetteville, AR.

Pritts, M. 2008. Primocane-fruiting raspberry production. HortScience 43(6)1640-1641.

Rom, C., E. Garcia, D. Johnson, and J. Popp. 2015. Extending the Market Season with High Tunnel Technology for Organic Fruit Production Final Report for LS12-250 SARE. 1 Feb 2013. <https://projects.sare.org/project-reports/ls12-250/>

Shahbandeh, M. 2019. Leading raspberry producing countries worldwide in 2017 (in 1,000 metric tons). 1 Dec 2020. <https://www.statista.com/statistics/967389/raspberry-producer-volume-worldwide/>

Weber, C. 2018. High tunnel performance of seven primocane red raspberry cultivars in western NY. J. Amer. Pomol. Soc. 72(3):195-201.

Weber, C. 2012. Raspberry variety review. Cornell Fruit Berry Resources. 1 Feb. 2013. <https://cpb-us-e1.wpmucdn.com/blogs.cornell.edu/dist/5/7316/files/2017/01/rasp-pdf-2iqcv6g.pdf>

Weber, C. 2010. Raspberry production in high tunnels. N.Y. Fruit Quart. 18:1.

Weber, C. (n. d.) ‘Crimson Giant: A new late season primocane raspberry. Cornell Univ.. Poster. 1 Feb 2020. <https://ctl.cornell.edu/wp-content/uploads/plants/Crimson-Giant-Poster-small.pdf>