

Project Title: New Blackberry Cultivar Testing for Orange Rust Resistance and Comprehensive Blackberry Grower Outreach

Final Report to OPGMA for the 2024 OVSFRDP Funded Blackberry Project

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Here is the final report of our blackberry project that was entitled “New Blackberry Cultivar Testing for Orange Rust Resistance and Comprehensive Blackberry Grower Outreach.” We conducted two field trials of blackberry orange rust disease resistance, one at OSU South Centers in Piketon and one at a commercial farm in Chillicothe, Ohio. Both blackberry cultivars ‘Cand’ and ‘Ponca’ showed a disease resistance rating of five out of a scale of 1 to 5 at both locations. A rating of five means a cultivar is highly resistant to orange rust. Dr. Gary Gao also visited quite a few blackberry farm in Ohio and asked a few blackberry growers about their experiences with the orange rust resistance of ‘Caddo’ and ‘Ponca.’ Several growers indicated that these two cultivars have not shown any signs of orange rust in their plantings. Based on our results and growers’ expenses, we can say that ‘Caddo’ and ‘Ponca’ are resistant to orange rust.

Since this assessment was based a one-year study and a few years of growers’ experiences, we can never be 100% sure. In addition, orange rust can still mutate. No one knows how likely that will happen though.

Here are the descriptions of Caddo and Ponca at the Indiana Berry Company’s website:

‘Caddo’: “(Patent PP3,115) Caddo is a thornless erect, floricanefruiting blackberry with large berries, very good fruit flavor, a good option for local-market production and home gardens, an early mid-season cultivar choice. Plants have exhibited very good health with consistently healthy floricanefruit leaves, proven to be disease free, having shown no orange rust, anthracnose or cane-leaf rust in all research trials. Winter hardiness has been comparable to Ouachita, and has shown very limited winter injury to a low of 1F.”

‘Ponca’: “(Patent PP33,330) Ponca is a high-yielding thornless blackberry, with erect canes, medium-sized fruit enhanced sweetness and good post-harvest handling traits. A

commercial cultivar with good potential as an early-market berry for shipping, local market production and home garden use. Berries average 6.8 grams. It has shown to be disease-free, showing no orange rust or anthracnose and limited cane or leaf rust in research trials. Information Courtesy of Indiana Berry Company.”

Growers should temper their enthusiasm toward ‘Caddo’ and ‘Ponca.’ Dr. Gao has heard from several growers that these two cultivars are not vigorous for Rotatable Cross Trellis system for high yields and profitability. Growers can still grow them in a traditional hedge row system. Closer planting spacing like 3’ between plants may be needed to compensate for their lower vigor. In addition, the relative susceptibility to cold injuries could be another risk factor since its cold hardiness is similar to those of other University of Arkansas releases like ‘Ouachita’ and ‘Natchez.’

‘Ouachita’ remains the “best” blackberry cultivar for Rotatable Cross Arm trellis in Ohio. ‘Natchez’ is second. Orange rust can be managed with judicious use of fungicides since orange rust has a complex disease cycle. Both spring and fall fungicide applications are critical for the successful control of this disease. Growers can refer to the OSU Fact sheet PLANPATH-Fru-30 at <https://ohioline.osu.edu/factsheet/plpath-fru-30> for disease diagnosis and the Midwest Fruit Pest Management Guide at <https://ag.purdue.edu/departments/hla/extension/sfg-sprayguide.html> for a detailed spray schedule and a list of labeled fungicides.

Growers are also cautioned that the profitability of blackberry production in the RCA system in Ohio is being challenged by huge glut of blackberries shipped in from California in July and August during a narrow window in which RCA blackberries were produced in Ohio. It is getting much harder for our growers to achieve competitive prices for their blackberries.

Dr. Gary Gao submitted an article to OPGMA, and his article was published in the December issue of OPGMA Today. He will submit another article for the next issue of OPGMA Today when the call for articles and submissions comes out in 2025. He and his project team have completed all of the deliverables as outlined in our proposal.

As of December 30, 2024, we have expended all \$6,000 that were approved for the project. Dr. Gao had to make some revisions to our budget. He emailed OPGMA for approval and was asked to include the budget revisions in the interim report. He meant to include them in the interim report. However, he forgot to do that due to many distractions at work during that period. He expresses his sincere apologies.

Please see the following table on this page for the original budget and final expenditures. A financial representative from OSU will submit an invoice for reimbursement in 2025.

Blackberry Project Budget and Final Expenditures (12/30/2024)

Category	Original Budget	Final Expenditures	Notes
Personnel	\$3,500	\$3,924.36	Student wages were more than anticipated.
Equipment	\$1,000	\$0*	We reallocated funds from "Equipment" toward "personnel" and "travel."
Supplies	\$1,000	\$953.53**	We got research discounts for our supplies and saved a few dollars.
Other: Travel	\$500	\$1122.11	Dr. Gao visited more growers' farms than anticipated for data collection and outreach.
Total:	\$6,000	\$6,000***	We managed to keep all expenses within the total amount.
*We reallocated the \$424.36 to "Personnel" and \$575.64 to "Other as Travel." **We reallocated \$46.47 toward travel. ***OSU donated \$700 for trellis and more \$\$ for the use of our farm equipment.			

Dr. Gary Gao wanted to thank Ryan Slaughter for helping with disease ratings at the commercial fruit farm in Chillicothe, Ohio. He would like to thank Dr. Pengfei Wen, a visiting scholar from China, his help with inoculating the blackberry plants with orange rust spores, Ms. Lane Song for her help with disease ratings at OSU South Centers in Piketon. Dr. Gao would also like to thank Mr. Thom Harker, Mr. Wayne Lewis and a summer student intern for planting raspberry plants, plot maintenance and data collection. Dr. Gao wants to express his sincere appreciation to the board of OVSFRDP for its financial support of this project.

The Information below was included in the interim report submitted to OVSFRPD board on October 23, 2024.

Orange Rust

One of the main challenges in blackberry production is orange rust which is caused by the fungus *Arthuriomyces peckianus*. According to the Ohio Extension fact sheet, #PLPATH-FRU-30, Navaho, Ouachita, Chickasaw, Chester, Triple Crown, Darrow, and Humble are susceptible to orange. Ouachita happens to be one of the leading blackberry cultivars for the RCA

production system in Ohio. Caddo and Ponca are two recent releases from the University Arkansas and are supposed to be resistant to orange rust. This funded project was designed to verify this claim based on the results from our field trials and grower observations.

We purchased 100 each of Caddo and Ponca bushes since they were advertised as orange rust resistant. Twenty-five each of Caddo and Ponca were planted around blackberry bushes that showed orange rust at South Centers in Piketon in the past while 75 each of Caddo and Ponca were planted right next to the blackberry bushes with visible orange rust symptoms at Hirsch's Fruit Farm in Chillicothe in May 2024.



Blackberry leaves with orange rust on leaves. Photo by Dr. Gary Gao, The Ohio State University.



Dr. Pengfei Wen, a Chinese Senior Visiting Scholar from Shanxi Agricultural University, used the orange rust infect leaves to inoculate orange rust on young Caddo and Ponca plants.

We inoculated some of the Caddo and Ponca plants by robbing both upper and lower leaves of Caddo and Ponca plants on May 20, 2024, at our grower cooperator's farm in Chillicothe, Ohio. Ryan Slaughter, Agricultural and Natural Extension Educator in Ross County, inoculated all the remaining Caddo and Ponca plants a week later.

Ryan Slaughter has gone back to our grower cooperator's farm on the regular basis to check for orange rust symptoms from June to October. So far, both Caddo and Ponca have not shown any orange rust symptoms. We have not observed any orange rust symptoms on the Caddo and Ponca plants in our trial at South Centers in Piketon.

Dr. Gary Gao has traveled across Ohio to talk with growers about their experiences with Caddo and Ponca. Among all of the growers who grow or grew Caddo and/or Ponca, nobody has experienced orange rust on Caddo and Ponca yet. Our initial trials in 2024 at two locations and growers' experiences showed Caddo and Ponca have resistance to orange rust. However, a multi-year study is needed to be 100% sure.

Even though Caddo and Ponca produce really sweet fruits with low acidity and are believed to be resistant to orange rust, growers are still hesitant to grow these two new varieties. This is because both varieties are not very vigorous and may not be well suited for Rotatable Cross Trellis system under their current plant spacing of 5' or 6'. Caddo and Ponca seem to have a hard time filling the entire trellised and thus have much lower yields than leading cultivars like Ouachita, Natchez, and Triple Crown. I wonder if a plant spacing of 3' with a fan system could compensate the lower vigor of Caddo and Ponca. Additional trials are definitely needed though.

Growing Blackberries on Rotatable Cross-Arm Trellis in Ohio

Rotatable cross arm (RAC) trellis has become a standard blackberry trellising for consistent blackberry production in Ohio and beyond due to inadequate cold hardiness of most blackberry cultivars and ever-changing weather patterns. More and more growers are getting high proficient in managing cane training, winter protection, fruit harvest, marketing and many other aspects of this highly specialized blackberry production system. There have been some challenges and advances in blackberry production system.

Advances in RCA Trellising System

The RCA trellis system was developed by Dr. Fumi Takeda of USDA Agricultural Service (ARS). The RCA trellis in conjunction with cane training system were shown to significantly improve machine harvesting, increased hand harvest efficiency, and most importantly improved winter survival of floricanes for a successful harvest. The RCA system was further

refined and commercialized by Mr. Richard Barnes of Trellis Growing Systems of Fort Wayne, Indiana. The system has turned into a very useful blackberry production system for growers in Ohio and many other states. Three primocanes are typically trained horizontally to encourage formation of laterals. The laterals are first tied to the short training arm and then shifted over to the long training arm of the RCA trellis. This cane training method is classified as the traditional cane training system.



Dr. Fumi Takeda of USDA ARS., Photo by Dr. Gary Gao, The Ohio State University.



An RCA trellis blackberry production system in southern Ohio. Photo by Dr. Gary Gao, The Ohio State University.

A new cane training system was developed and trialed by a group of fruit research and extension professional at the University of Arkansas. The new system is called the “Fan System” and is being adopted by more and more blackberry growers.

RCA – Traditional Cane Training Method

Here are the steps of managing blackberry canes using the traditional cane training method.

Year One:

1. Prepare the raised beds with weed fabric. Rows are spaced at 12 feet wide and 15 feet row spacing may be more desirable.
2. Plant blackberry bushes in spring at a plant spacing of 5 feet on center. Some common blackberry cultivars suited for RCA are Caddo, Chester, Natchez, Ouachita, Osage, Ponca and Triple Crown.
3. Install the RCA trellis shortly after planting. Refer to the instructions from the trellis supplier for proper installation techniques.



A new blackberry planting on RCA. Photo by Dr. Gary Gao, The Ohio State University.

4. Train new primocanes on the long arm of the trellis by using Anchor Bands, or Branchloks. Anchor bands and Branchloks can be purchased from suppliers.
5. New canes can be as short as three feet and as long as 10 feet depending on the varieties, soil conditions, fertigation regime and weather condition.
6. The long primocanes can be looped around the top wire. These looped canes can be useful in filling the trellis and helping shade the fruits in the following year from too much sun exposure.
7. Make a dormant fungicide spray after the plants are hardened off in November and before trellis is rotated to the ground level.
8. RCA trellis is typically rotated to the ground level around late November to mid-December. This timing is dependent on the temperatures around that time.
9. Blackberry bushes are then covered with a floating row covers of 3 oz. weight.
10. Row covers are then weighted down with sandbags.
11. If warm weather is predicted for a few days in a row, venting by opening up the ends of the row covers is beneficial to keep the plants dormant.

Year Two:

1. Row covers can be lifted late February to early March. However, the row covers should be left in the field for unexpected cold temperatures.
2. The trellis is lifted to the vertical position for the first fungicide spray.
3. The trellis is then lowered down to the ground to the “bud break” position.
4. Once the flower buds are visible and start opening, the trellis is raised to the horizontal or “flowering” position.



RCA trellis at the horizontal or the “flowering” position. Photo by Dr. Gary Gao, The Ohio State University.

5. Make sure honeybee hives or bumblebees are available for pollination.
6. Once the plants finished blooming, the trellis is then raised to the fruiting position as shown in the picture below.



The blackberry rows on the left are in the “fruiting position” while the rows on the right side are in the “flowering position.” Photo by Dr. Gary Gao, The Ohio State University.

7. When primocanes emerge in spring, three true primocanes are gently bent to a horizontal position along the training wire on the side with the shorter arm. Keep in

mind that canes are bridle. It is advisable to do cane training around mid-day when the primocanes are more pliable. When the primocanes reach the adjacent plant, they are then tipped so that the canes will no longer elongate.

8. When the laterals emerge, they are carefully clipped to the training wire on the shorter arm.
9. A modest harvest is expected from the floricanes on the longer training arm during the second year.
10. After floricanes produce fruit, they are then cut off at the ground level. The laterals on the side of shorter training arm are then shifted and clipped to the wires on the side with the longer arm.
12. Most laterals should reach the top wire this year.
13. Some long primocanes can be looped around the top wire. These looped canes can be useful in filling the trellis and helping shade the fruits in the following year from too much sun exposure.
14. Make a dormant fungicide spray after the plants are hardened off in November and before trellis is rotated to the ground level.
15. RCA trellis is typically rotated to the ground level around late November to mid-December. This timing is dependent on the temperatures around that time.
16. Blackberry bushes are then covered with a floating row covers of 3 oz. weight.
17. Row covers are then weighted down with sandbags.
18. If warm weather is predicted for a few days in a row, venting by opening up the ends of the row covers is beneficial to keep the plants dormant.

Years Three and Beyond:

1. Row covers can be lifted late February to early March. However, the row covers should be left in the field for unexpected cold temperatures.
2. The trellis is lifted to the vertical position for the first fungicide spray.
3. The trellis is then lowered down to the ground to the “bud break” position.
4. Once the flower buds are visible and start opening, the trellis is raised to the horizontal or “flowering” position. Make sure honeybee hives or bumblebees are available for pollination.
5. Once the plants finished blooming, the trellis is then raised to the fruiting position as shown in the picture below.



The blackberry trellises in their “fruiting position.” Photo by Dr. Gary Gao, The Ohio State University.

6. When primocanes emerge in spring, three true primocanes in the middle of the row between the two training wires are selected and then gently bent to a horizontal position along the training wire on the side with the shorter arm. Keep in mind that canes are fragile and can be broken easily. It is better to do cane training around mid-day when the primocanes are more pliable. When the primocanes reach the adjacent plant, they are then tipped so that the canes will no longer elongate. Do not confuse the flowering shoots coming from the side of the buried canes or the crown. The flowering shoots tend to come out early and grow more sideways. True primocanes have reddish leaves and octagonal stems and grow vertically.
7. When the laterals emerge, they are carefully clipped to the training wires on the shorter arm.
8. A full harvest is expected from the floricanes on the longer training arm during the third year and on.
9. After floricanes produce fruit, they are then cut off at the ground level. The laterals on the side of shorter training arm are then shifted and clipped to the wires on the side with the longer arm.
10. Most laterals should reach the top wire this year.
11. Make a dormant fungicide spray after the plants are hardened off in November and before trellis is rotated to the ground level.
12. RCA trellis is typically rotated to the ground level around late November to mid-December. This timing is dependent on the temperatures around that time.

13. Blackberry bushes are then covered with a floating row covers of 3 oz. weight.

14. Row covers are then weighted down with sandbags.

If warm weather is predicted for a few days in a row, venting by opening up the ends of the row covers is beneficial to keep the plants dormant.

RCA – New “Fan” Training System

Year One:

1. The recommended plant spacing is 3 feet for the RCA – “Fan” training method instead of 5 feet for the RCA – Traditional method. The row spacing is still 12 feet.
2. Flip the trellises to the fruiting or harvesting position first.
3. Primocanes are selected and guided to grow between two bending wires. They are then selected and tied to the training wire on the long arm side. No cane tipping is done during the season of planting.
4. Space the primocanes about 2 inches apart. If the primocanes extend over the top of the trellis, leave them alone. Tip the canes at 6-8 inches above the top wire either in late fall before the trellis is flipped down to the winter position or early spring when the trellis is flipped up for the first fungicide spray.
5. Around late November or early December, remove the clips or the ties from the canes at the lowest training wire before flipping the trellis down to the winter position. This will significantly reduce the cane cracking from the 90° bend.
6. Flip the trellis down to the winter position.
7. Cover the trellis with 3 oz. row covers for the winter. Weigh the row covers down with sandbags.

Year Two:

1. Uncover the trellis around late February or early March. Leave the row covers in the field since you may need to cover the trellis again.
2. Raise the trellis for the first fungicide spray.
3. When the buds start breaking in spring, flip the trellis to the horizontal or flowering position. This typically occurs in late February or early March. Keep in mind that row covers still need to be put back on if a cold snap is forecasted.
4. Keep the trellis in the flowering position until all of the king flowers open.
5. Once the flower buds are visible and start opening, the trellis is raised to the horizontal or “flowering” position.
6. Make sure honeybee hives or bumblebees are available for pollination.

7. When primocanes emerge in spring, select three to six healthy primocanes between the bottom training wires and tip them at the height of bottom training wires or slightly above.
8. Tip the canes slightly above a bud on the primocanes. This tipping process may take a month when all of the needed canes are tipped. All the new laterals are placed on the side of training wire with the shorter arm.
9. After floricanes produce fruit, they are then cut off at the ground level.
10. The laterals on the side of shorter training arm are then shifted and clipped to the wires on the side with the longer arm.
11. Make a dormant fungicide spray after the plants are hardened off in November and before trellis is rotated to the ground level.
12. RCA trellis is typically rotated to the ground level around late November to mid-December. This timing is dependent on the temperatures around that time.
13. Blackberry bushes are then covered with a floating row covers of 3 oz. weight.
14. Row covers are then weighted down with sandbags.
15. If warm weather is predicted for a few days in a row, venting by opening up the ends of the row covers is beneficial to keep the plants dormant.

Years Three and On

1. Uncover the trellis around late February or early March. Leave the row covers in the field since you may need to cover the trellis again.
2. Raise the trellis for the first fungicide spray.
3. When the buds start breaking in spring, flip them trellis to the horizontal or flowering position. This typically occurs in late February or early March. Keep in mind that row covers still need to be put back on if a cold snap is forecasted.
4. Keep the trellis in the flowering position until all of the king flowers open.
5. Once the flower buds are visible and start opening, the trellis is raised to the horizontal or “flowering” position.
6. Make sure honeybee hives or bumblebees are available for pollination.
7. When primocanes emerge in spring, select three to six healthy primocanes between the bottom training wires and tip them at the height of bottom training wires or slightly above.
8. Tip the canes slightly above a bud on the primocanes. This tipping process may take a month when all of the needed canes are tipped. All the new laterals are placed on the side of training wire with the shorter arm.
9. After floricanes produce fruit, they are then cut off at the ground level.
10. The laterals on the side of shorter training arm are then shifted and clipped to the wires on the side with the longer arm.

11. Remove the clips from the laterals near the bottom training wires around late November to keep the laterals from breaking. Make a dormant fungicide spray after the plants are hardened off in November.
12. Flip the trellis down to the ground around late November to mid-December. This timing is dependent on the temperatures around that time.
13. Blackberry trellises then covered with a floating row covers of 3 oz. weight.
14. Row covers are then weighted down with sandbags.
15. If warm weather is predicted for a few days in a row, venting by opening up the ends of the row covers is beneficial to keep the plants dormant.



Blackberry bushes on RCA in a possible conversion to new Fan training system. Note the floricanes have been pruned off for the year. Photo by Dr. Gary Gao, The Ohio State University.

There are several advantages with the RCA system. They are substantial winter protection from cold temperatures and drying winds, greatly improved harvesting efficiency, consistent production year after year, and much greater selections of superior tasting blackberry cultivars. There are also disadvantages with the RCA system. Some of them are high costs of establishment, a steep learning curve, and a high labor requirement.

Growers are encouraged to develop a detailed business plan and also check out their marketing options before committing to a large investment for an RCA system. The cost of establishment can be as high as \$20,000 per acre. Several growers in Ohio have installed blackberry plantings

using the system. Perspective growers will have to their own homework to make sure economics work out.

For information on theory and application of RCA, refer to an article "Method for Producing Long-cane Blackberry Plants" by Fumiomi Takeda and Jorge Soria. The article is available online at <http://horttech.ashspublications.org/content/21/5/563.full>

Rotatable Cross Arm Trellis can be purchased through Trellis Growing Systems, LLC, which is online at <http://trellisgrowingsystems.com/products/rotating-cross-arm-rca-trellis-system/> For a detailed cane training techniques, refer to a presentation entitled "Growing Blackberries on a Rotatable Canopy Production" by Dr. Fumi Takeda. The Power Point File is available online at <https://www.uiarchive.web.illinois.edu/mms/downloads/47252.pdf> Additional useful links are listed below for growers to obtain more information.

Videos on Rotatable Cross Arm Trellis: Traditional and New Fan Training

A very nice video series RCA for both traditional horizontal cane training and new Fan system have been created by a group of researchers and extension professional with the University of Arkansas.

Here is the link to the five-part video series: Blackberry RCA Video Series – University of Arkansas:

<https://www.uaex.uada.edu/farm-ranch/crops-commercial-horticulture/horticulture/commercial-fruit-production/rca-trellis-blackberry.aspx>

This video series was very well done. There is no need to create or recreate a new video of our own.

Useful Blackberry Links

Sweet-Ark Caddo Blackberry: <https://www.youtube.com/watch?v=Azm1DJ3tVLE>

Ponca Blackberry: <https://www.youtube.com/watch?v=DJKLtYYBpIs>

Ouachita Blackberry: <https://www.youtube.com/watch?v=RHG9-eLOriE>

Natchez Blackberry: <https://www.youtube.com/watch?v=5wc0-lgcp9Q>

Blackberry orange rust management by Dr. John Clark:

<https://www.raspberryblackberry.com/is-it-blackberry-leaf-rust-or-orange-rust/>

Orange Rust – OSU: <https://ohioline.osu.edu/factsheet/plpath-fru-30>

Blackberry RCA Guide – University of Arkansas:

<https://www.uaex.uada.edu/publications/MP575.pdf>

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