An Innovative Approach to Training Blackberries

Fumiomi Takeda

Appalachian Fruit Research Station, Agricultural Research Service, US Department of Agriculture, Kearneysville, West Virginia 25430 USA

Technical Abstract: The rotating cross-arm (RCA) technology combines a unique trellis design and cane training protocol. Developed over the last two decades, this technology is beginning to have an impact on the blackberry (Genus *Rubus*, subgenus R*ubus*) industry in the United States (US). It has been successfully transferred to growers in more than 21 states in the last two years and contributed to increasing the blackberry acreage by about ~ 100 ha in the eastern US. Our research and development effort on the RCA technology has shown that 1) winter injury can be reduced by modifying the crop environment and production techniques, 2) white drupe formation can be reduced when fruit is positioned away from direct sunlight, and 3) harvest efficiency is improved when the fruit positioned on one side of the row. Our research has also shown that RCA technology can be used to generate several times more one- node floricane cuttings and long-cane plants than traditional propagation methods. The enclosure technique improved rooting of some cultivars, but there were recalcitrant cultivars like 'Apache'. Auxin analyses suggested a possible link between IAA concentrations
and root induction in floricane cuttings. Consistent production of blackberries was achieved in areas with minimum winter temperatures below – 20 °C with the RCA technology. This technology allows the canes to be positioned close to the ground in winter and covered with a floating rowcover. An unexpected result of this winter protection system was some leaves on the floricane remained green throughout the spring and were photosynthetically functional in spring.

Keywords: *Rubus,* winter injury, trellis, primocane, floricane, drupe, sun damage, photosynthesis, auxin, long-cane plants, cane training, canopy management, vegetative propagation

Conventional blackberry production in North America requires high labor and chemical inputs, making production more difficult for blackberry growers in the United States (US) to maintain a profitable operation with ever-increasing competition and market share by countries like Mexico, which is the source of nearly 70% of fresh blackberries sold in the US. This has renewed interest in improving cropping efficiency and production systems in order to increase fruit production and quality at times when blackberry shipments from Mexico are low. According to a recent survey [1], the major areas for fresh blackberry production areas are in the western (California and Oregon) and southern (Arkansas, Georgia, and Texas) US. However, in the northcentral and northeastern regions of the US, blackberry production has been limited due to a number of environmental constraints such as regular occurrence of lethal low winter temperatures < –20 °C (Fig. 1) and spring freezes (< –4 °C) occurring from the time of budbreak in March to bloom in May. Extremely high summer temperatures and solar radiation levels cause drupes to turn white and reduce pack-out in some cultivars. These production issues in part have been addressed with innovations in production practices and plant canopy manipulation, and with proper cultivar selection [2 – 6]. These improvements have fostered expansion of commercial blackberry production and have helped mitigate environmental factors that limit profit potential.

Interest in growing blackberries has increased among the US farmers looking for alternative crops that capture niche markets and have potential for high returns on investment. Blackberry acreage in the US increased 25% from 1995 to 2005 to about 4,800 ha. Over half of this acreage is in Oregon and the Pacific Northwest where the production is mainly for the processing industry. The top five states for fresh-market blackberry production are Oregon (300 ha), California (280 ha), Texas (270 ha), Arkansas (240 ha), and North Carolina (180 ha). By 2015, the total blackberry production acreage is expected to increase to 5,700 ha (B. Strik, personal communication). Much of the new acreage (900 ha) will be primarily for fresh-market production. In vast area of northeastern and northcentral US (i.e., Pennsylvania, Ohio, New York, Massachusetts, West Virginia, Maryland, New Jersey, Delaware, Indiana, Illinois, Iowa, Kansas, and Kentucky), the total acreage for blackberries is currently estimated at less than 290 ha [1] with much of the fruit sold locally. Nearly 100 ha of this acreage in the northcentral and northeastern US have been established in the last 3 years (Fig. 2) using a novel trellis design called the rotating cross-arm (RCA) trellis. The commercial RCA trellis (Fig. 3) is constructed of fiberglass reinforced plastic components manufactured by the pultrusion process. It has a post which is ~50 cm high with two plates attached at the top. A long and a short cross-arm are assembled to the plates. The arms are secured to the plates with detent pins and are rotatable. There are trellis wires on both arms for securing lateral canes. In addition, two wires are threaded through holes in the plates. These wires are used for primocane cane training and repositioning the floricanes in late fall or early winter. The unique features of cane training and the RCA trellis design allow the plant canopy to be rotated easily from vertical in summer to horizontal in winter and back again to vertical in spring without breaking canes.

Production of blackberries is limited in the northcentral and northeastern US, classified as Plant Hardiness Zones 5 and 6, according to the 2012 USDA Plant Hardiness Zone Map [7], where the minimum temperatures below –23 ºC are common during the winter months (Fig. 1). In these colder areas, blackberry plants produce vigorous primocanes each growing season, but the buds and canes develop symptoms of low temperature injury and do not produce fruit in most years. While four-season high tunnels could be used to produce blackberry in areas with low winter temperatures (Marvin Pritts, personal communication), the high cost (>$100,000/ha) of high tunnels and other permanent structures has prevented growers from adapting the system for winter protecting blackberry plant. A less expensive winter protection system with the RCA technology has proven to provide sufficient winter protection for blackberries [4 – 6] and offers an opportunity for farmers in the northcentral and northeastern states to produce blackberries for local and distant markets when more southern areas have finished production.

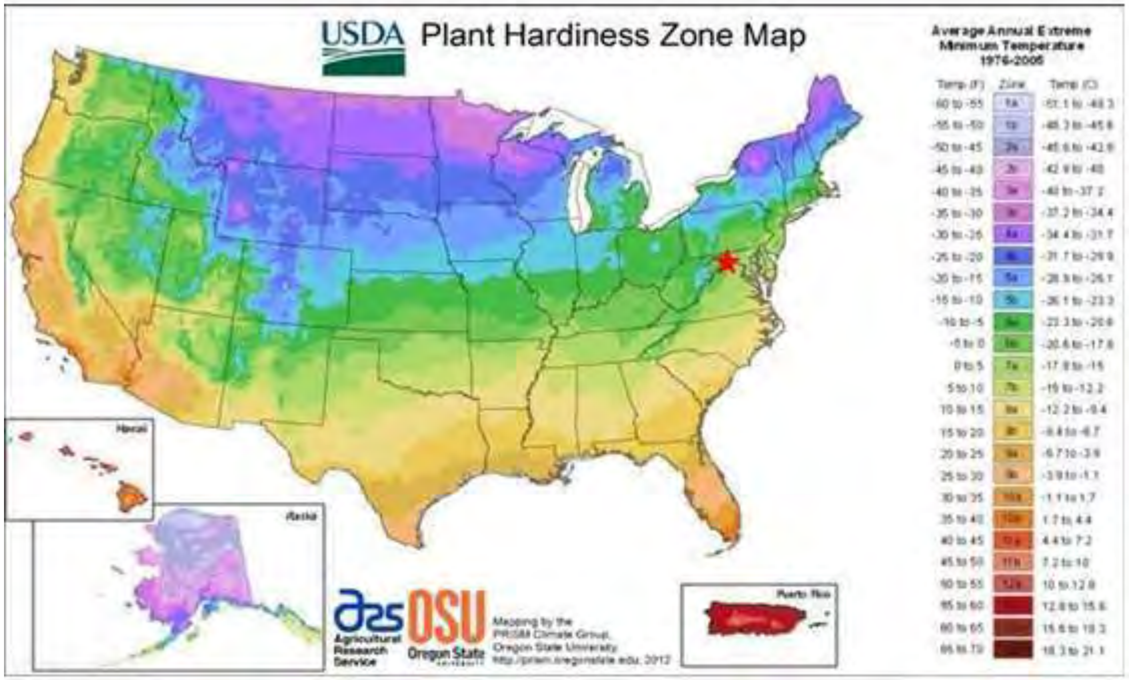

Fig. 1. The 2012 USDA Plant Hardiness Zone Map (http://planthardiness.ars.usda.gov/PHZMWeb/). Little or no commercial blackberry production in areas in dark green, blue, and purple colors exists currently. These areas are the northcentral and northeastern United States where average extreme annual minimum temperatures in the –20 to –25 °C or below are common. The location of Appalachian Fruit Research Station is indicated by a red star.

Fig. 2. States with commercial size (> 0.5 ha) blackberry plantings with the rotating cross-arm trellis and cane training system developed by USDA-ARS research are highlighted in white. This technology is being used by blackberry growers in the vast region encompassing the central and eastern US. California (CA), Georgia (GA), Illinois (IL), Indiana (IN), Iowa (IA), Kentucky (KY), Maryland (MD), Massachusetts (MA), Michigan (MI), Missouri (MO), New Jersey (NJ), New York (NY), North Carolina (NC), Ohio (OH), Oklahoma (OK), Pennsylvania (PA), Texas (TX), Tennessee (TN), Virginia (VA), and West Virginia (WV).

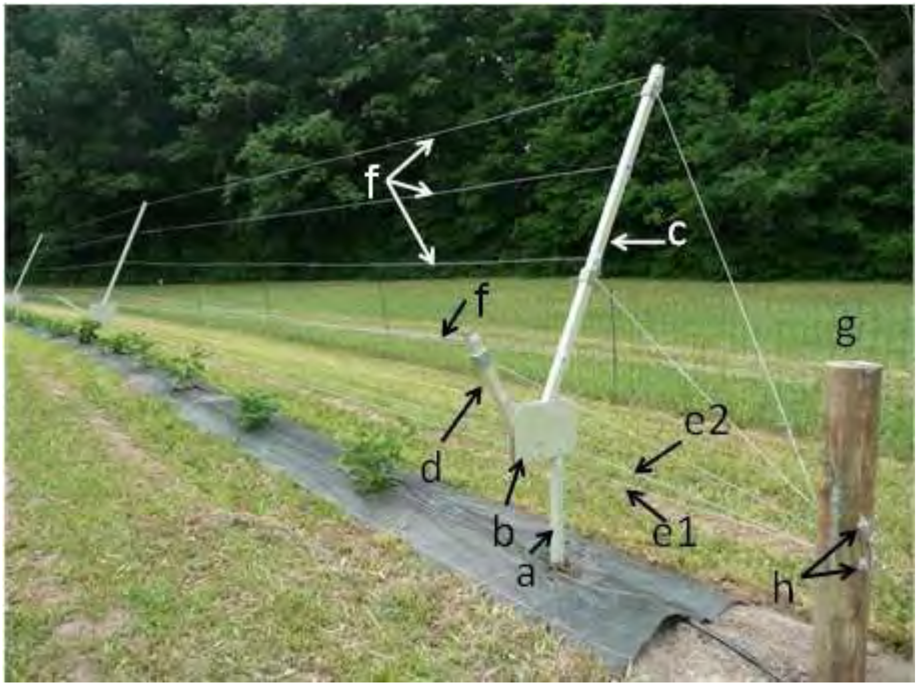

Fig. 3. The rotating cross-arm (RCA) trellis. The commercial version is constructed of fiberglass reinforced plastic components manufactured by the pultrusion process. A) The trellis consists of a post (~50 cm) (a) which has two plates (b) attached at the top. A long (c) and a short (d) cross-arm is secured between the two plates with detent pins. Both cross-arms are rotatable. There are two cane training wires (e1 and e2) that are threaded through holes in the plates. Additional trellis wires (f) are threaded through both cross-arms and secured to end trellis assembly arms. The wires in the foreground are connected to a wooden tie-back post (g). The primocanes are placed on the training wire below the short cross-arm (e1). Wires terminate at the wooden tie-back post and on end trellis assembly arms on the first and last posts of each row with a "Quik-End tensioner (h) which has internal spring-loaded clamps. In winter the canes are pushed over to the training wire under the long cross-arm (e2). For details on primocane training see Fig. 3. Assembly and installation instructions are available from Trellis Growing Systems, Inc. (www.trellisgrowingsystem.com). Photo provided by Trellis Growing System, Inc.

Fig. 4. Primocane training on the rotatable cross-arm (RCA) trellis in spring. **A**) Up to three primocanes are trained. The primocane (a) has grown about 15 cm above the training wire and is ready for bending. The succulent tip portion of the primocane is carefully bent and tied to the training wire as shown below the hand to force it to grow horizontally (b). The tip portion of horizontally trained primocanes must be tied periodically to the training wire or it will revert back to growing upward (c). The floricanes have been bundled and secured to the second training wire on the RCA trellis the previous fall (d). B) Bent primocanes (a) have grown about 1.7 m on the training wire. The portion must be secured on the training wire (b). Each primocane is tipped when the growing point reaches the adjacent plant. Secondary shoots (e.g. lateral canes) (c) develop from axillary buds on the primocanes. All lateral canes that emerge from nodes below the bend point are broken off. A floricane (d) and its lateral canes (e) that bear current year's crop can be seen behind this year's primocanes (a). C) Primocane growth on the RCA trellis in late summer. Three primocanes (a) have been secured to the training wire. The section of these canes that is oriented horizontally (b) has a length of about 1.7 m. Note many lateral canes (c) have developed from this cane section. The leaves have been removed to reveal the origin of lateral canes.

Fig. 5. Blackberry plants on the rotatable cross-arm trellis at bloom. A) The long cross-arms are oriented horizontally. Note the top of the post (arrow) on left side. The lateral canes that were secured to the wire on the long cross-arms have produced flower shoots and all have grown upward. Flower shoots that develop from axillary buds oriented down on the lateral canes will curve and grow upward between lateral canes. B) Soon after all the flower shoots have a few open flowers the cross-arms can be rotated upward and beyond vertical. By this time, the rachis (inflorescence axis) is woody and will not curve upward. The upward rotation of the cross-arms positions the fruit on one side of the row. Photos provided by Bill Jacobs.

Fig. 6. Winter protection of blackberry plants trained on the rotatable cross-arm trellis. A) Research plots at the Appalachian Fruit Research Station. In the row on left, the cross-arms have been rotated down to position the lateral canes close to the ground. The plot in the foreground has been covered with a floating rowcover and the perimeter secured with bags of stones. B) A large commercial blackberry planting in Circleville, OH. Rows that are about 100-m long have been covered with a floating rowcover. Snow accumulation provides additional insulation. Note that there are two rows on the far left side that have not been covered.

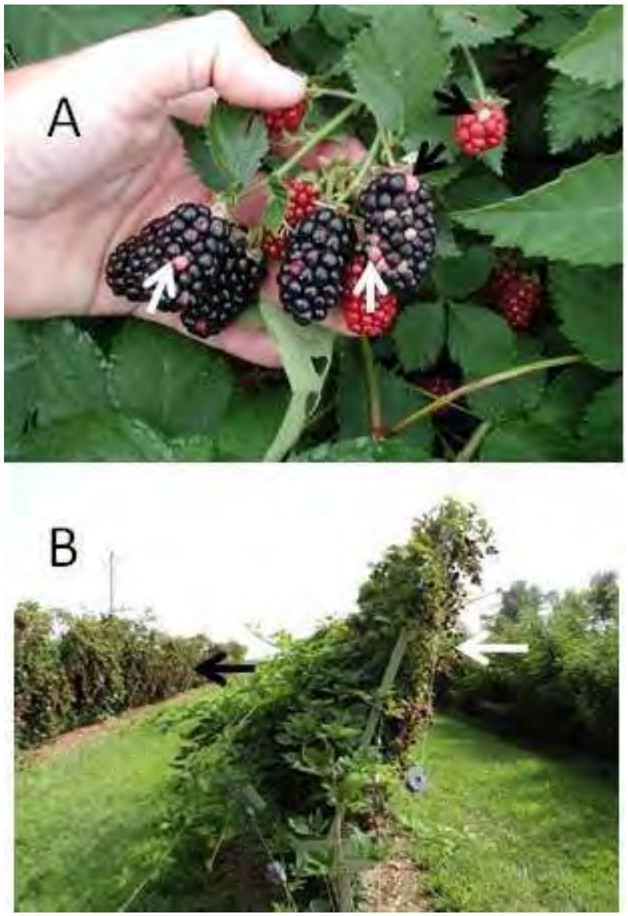

Fig. 7. Mitigating adverse environmental conditions with canopy management. A) White drupe (arrows) formation in 'Apache' blackberry. B) By using the rotating cross-arm trellis and orienting the rows in east-west direction fruit could be positioned on the north-side of the row (arrow) and away from exposure to direct sunlight. Photos provided by Dr. John Clark and Trellis Growing System, Inc., respectively.