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Propagation of thornless Arkansas blackberries by hardwood cuttings

Mark M. Bray^{}, Curt R. Rom[†], and John R. Clark[§]*

ABSTRACT

Effects of auxin application and cutting location on canes on adventitious root development in hardwood cuttings of three Arkansas thornless blackberry cultivars were studied. Dormant canes were collected from one-year-old plants of 'Apache', 'Arapaho', and 'Navaho' and stored in a cold room until February. Two- or three-node cuttings were taken from the canes at apical, mid, and basal locations along the cane and were placed under intermittent mist in a perlite-filled greenhouse bed. Cuttings were either untreated or treated with auxin indole-3-butyric acid (IBA), applied as a liquid quick dip at 0.3%. In general, cutting diameter was greatest for basal and smallest for apical cuttings. Significant interactions were observed for cultivar and cutting location and for cultivar and auxin treatment for rooting. 'Apache' with auxin treatment had the highest rooting percentage, and 'Arapaho' and 'Navaho' with auxin the lowest. For cuttings that rooted, auxin treatment increased the root rating, representing root system development, for 'Apache' and 'Navaho' but had no effect on 'Arapaho'.

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MEET THE STUDENT-AUTHOR

After graduating from Benton High School in 1992, I attended the University of Arkansas at Fayetteville where I majored in botany. While studying at the University of Arkansas, I worked as a research assistant for the Botany Department. I worked on a census project where I counted species of rare, threatened, and endangered wildflowers along the Buffalo National River. During this time, I also volunteered my time to the Ozark Natural Science Center. In 2001, I returned to the University of Arkansas to pursue a degree in horticulture. Since then, I have been actively involved with the Horticulture Club.

While pursuing my B.S. degree in horticulture, I received the Northwest Arkansas Tomato Growers Association Scholarship. During the summer of 2003, I worked as an Adair Scholar in the Plant Pathology Department at the University of Arkansas. My project was to identify and characterize a new plant virus affecting blackberries. I began graduate school in fall 2003 at the University of Arkansas. Before my senior year as a horticulture student, Dr. Rom and Dr. Clark suggested the idea for my undergraduate research project. Because of my interest in small fruits, the opportunity to study propagation methods for blackberries appealed to me. Since propagation guidelines have not been established for Arkansas thornless blackberries, the research project has the potential to provide useful information for the nursery industry.



Mark M. Bray

INTRODUCTION

Advances in blackberry cultivars from the University of Arkansas fruit breeding program have contributed significantly to the expansion of commercial blackberry production (Clark, 1999). Thornless blackberry cultivars released from the University of Arkansas breeding program that have contributed to this expansion include 'Apache' (Clark and Moore, 1999), 'Arapaho' (Moore and Clark, 1993), and 'Navaho' (Moore and Clark, 1989).

With this expansion the demand for plants has increased along with a need for improved methods of propagation (Busby and Himelrick, 1999). Nurseries have utilized various propagation techniques and types of vegetative material to propagate desirable genotypes. Common methods of propagating blackberries include: tip layering, leaf-bud cuttings, tissue culture, and root cuttings (Caldwell, 1984). Each method has its disadvantages. Tip-layering involves excessive hand labor to separate canes, few propagules are produced per plant, and weeds are difficult to manage. Successful propagation by tip-layering is also difficult to achieve with erect-cane genotypes. The leaf-bud softwood cutting method

has been utilized for high production with some success. Leaf-bud location along cane was observed to affect rooting; consequently, this method has not been widely adopted (Caldwell, 1984). The disadvantage of the tissue culture method is the large initial investment of high-tech expensive propagation equipment. Therefore, the use of this method may not be appropriate for small nurseries. Indubitably, growers will choose the method of propagation that most greatly reduces production costs (Caldwell, 1984).

Hardwood cutting propagation is not used commercially but might be of value since the cane material utilized with this method is traditionally pruned and discarded. The advantages of propagating by hardwood cuttings would be the production of more propagules per plant, the utilization of excess cane material, and a possible reduction of the spread of virus infections. Propagation techniques that generate an increased number of propagules per plant, from otherwise useless, excess plant material would reduce propagation costs for nurseries and could reduce plant costs for growers. In addition to reduced costs, another benefit for growers would be a possible solution to virus transmission

among plants. By mass propagating from virus-indexed stock, growers would reduce the rate at which virus infections are spread (Ahrens, 1991). Furthermore, this method of propagation could be useful to plant breeding for timely pollen collection or manipulated pollination procedures (Lopez-Medina and Moore, 1997).

Propagation of blackberries by hardwood and softwood stem cuttings has been successfully achieved without the use of auxin rooting hormone. However, the application of auxin when propagating *Rubus* sp. by stem cuttings has proved valuable for root system enhancement (Busby and Himelrick, 1999; Williams and Norton, 1959). Busby and Himelrick (1999) reported that root development increased on 'Navaho' softwood cuttings treated with 0.3 and 0.8% K-IBA quick dip. Lopez-Medina and Moore (1997) reported that the application of 0.3% IBA improved the volume of roots formed in Arkansas erect-cane blackberries propagated by florican dormant stem cuttings. Our experiment further studied the propagation of thornless erect-cane blackberries by dormant hardwood cuttings. The purpose was to evaluate a mass propagation system that is simple and efficient for commercial production of several thornless Arkansas blackberries. Specific objectives were to evaluate the effects of cultivar, auxin, and cutting location on rooting of hardwood cuttings.

MATERIALS AND METHODS

On 9 Dec. 2002, at the University of Arkansas Agricultural Research and Extension Center, Fayetteville, one-year-old canes of 'Apache', 'Arapaho', and 'Navaho' were removed from plants grown in cold-frame growing beds and placed in sealed plastic bags. The canes were placed in cold storage at 7°C for approximately two months to satisfy chill requirement. Two- to three-node hardwood cuttings (10-12 cm long) were taken on 12 Feb. 2003. The cuttings were taken from three locations on the cane: apical, mid, or basal sections. The basal cut on each cutting was made at approximately 1.5 cm below the basal node. Cuttings were treated with either no hormone treatment (control) or treated with rooting hormone. The rooting hormone treatment consisted of a commercial auxin (0.3% IBA solution) with a quick dip of 1-3 s. Cuttings were immediately inserted approximately 5 cm deep into propagation beds consisting of a perlite rooting medium. The propagation beds were equipped with heating cables for bottom-heat at 22-25°C, and a mist system. The automatic intermittent mist system was set to mist for approximately 16 s every 10 min during daylight hours. Cuttings remained under mist for 45 d, and then were removed for evaluation of

root systems. Propagation beds were located in a heated greenhouse with daily minimum temperature of 15°C and a daily maximum of 25°C. No supplemental lighting was provided. Rooted cuttings were potted in soil-less medium for plant establishment.

The experimental design was a three by two factorial design (three cultivars and two auxin treatments) arranged in a randomized complete block design with seven replications of three cuttings for each cultivar and auxin treatment. Treatments were blocked by location in mist beds. Data collected were cutting diameter, number of cuttings that rooted, and rooting rating. The number of cuttings that rooted was expressed as percentage of rooted cuttings. The rating system was a subjective rating of 0 to 5 where 0 = the absence of roots or a dead cutting, and 5 = an extensive root system. Data were analyzed by analysis of variance using Statistical Analysis System (SAS), and means separated by t-test.

RESULTS AND DISCUSSION

Analysis of cutting diameter indicated significant ($P < 0.05$) sources of variation were cutting location on cane, cultivar and the cultivar by location interaction. For rooting percentage, significant effects were auxin treatment and the cultivar by auxin treatment interaction. Rooting rating sources of variation that were significant were cultivar, auxin, and the cultivar by auxin interaction. Due to significant interactions of all variables, the interaction means will be presented.

Average diameters for apical cuttings of all three cultivars were similar (Table 1). Cuttings taken from mid sections of canes for 'Apache' and 'Navaho' were similar. However, mid-section cuttings of 'Arapaho' averaged 0.8 mm larger in diameter than 'Apache' mid-section cuttings, and 0.6 mm larger in diameter than for 'Navaho'. Furthermore, the average diameters of basal cuttings for all three cultivars were different. 'Arapaho' cuttings were the largest, averaging 0.8 mm larger in diameter than 'Apache', and 0.4 mm larger than 'Navaho'. Although there were some significant differences for cutting diameter, we thought the diameter differences for the cuttings would be negligible for potential rooting. This was confirmed by a Pearson Product Moment Correlation that was conducted on the cutting diameter and rooting percentage data. The results of the correlation were not significant ($P < 0.05$) and the r value = 0.15. These findings indicate that cutting diameter had no relationship to rooting in our study.

Significant auxin-by-cultivar interaction for rooting percentage was observed (Table 2). Within the no-auxin treatment, there were no significant differences among

cultivars in the control. However, within the auxin-applied treatment, there were significant differences among cultivars. Percent rooting for 'Arapaho' was greatly reduced (47.5% to 14.2%) with the application of auxin. The cultivar with the highest percent rooting was 'Apache' with auxin treatment (47.6%). However, auxin treatment reduced rooting percentage for 'Arapaho' and 'Navaho' compared to control. These findings indicate that with the auxin concentration used (0.3%), these three cultivars responded differently to auxin treatment. For cuttings that rooted, root rating had significant differences for cultivar and auxin treatment (Table 2). Root ratings for 'Apache' and 'Navaho' with auxin treatment were greater compared to non-treated control. 'Arapaho' cuttings that rooted showed no difference in rooting rating with auxin treatment compared to control.

Several studies on the propagation of blackberries by stem cuttings have been reported on with inconsistent performance records. Bobrowski, et al. (1996) reported that propagation by hardwood stem cuttings of blackberries is simple but rooting is not always satisfactory. Similarly, we observed that less than 50% of hardwood cuttings established roots. Zimmerman, et al. (1980) reported that node position on the cane had no significant effect on rooting of 1-node softwood cuttings, and that softwood cuttings rooted better than one-node, and much better than three-node, hardwood cuttings for cultivars 'Smoothstem' and 'Dirksen Thornless' blackberries. Zimmerman also reported that IBA had little effect on rooting of softwood and hardwood cuttings for cultivars 'Smoothstem' and 'Black Satin'. Lopez-Medina and Moore (1997) reported that significant differences in percentage of cuttings rooted occurred only for 'Arapaho' and 'Shawnee' but not 'Navaho'. In contrast with Zimmerman's findings, Lopez-Medina and Moore also reported that cultivar by position interaction effect was evident and IBA improved volume of roots formed (Lopez-Medina and Moore, 1997). Busby and Himelrick (1999) reported that thornless blackberry cultivars rooted easily from softwood cuttings in mist beds without the application of auxin, but that with auxin (0.3% and 0.8% IBA) root system development was enhanced for 'Navaho'. However, no specific auxin concentration consistently improved rooting for the cultivars tested. They suggested that a liquid quick dip in 0.3% to 0.8% IBA would enhance the rooting response in a range of blackberry cultivars.

The objective of this study was to determine the effects of auxin treatment and cutting location along canes of three Arkansas thornless blackberry cultivars. The findings suggest that propagation of thornless erect blackberries by hardwood cuttings is feasible, and may have some utility. However, the results indicate that

there are differing responses among cultivars with IBA rooting hormone. The findings indicated that although the quality of root systems may be enhanced with the use of rooting hormone, the percentage of rooted plants might be cultivar dependent. With this variation, one could speculate that different concentrations of rooting hormone may have variable effects on the rooting success of thornless erect blackberries. More research is necessary to achieve guidelines for propagating blackberries by hardwood cuttings.

Further studies of related interest may include research on plant establishment with regard to plant precocity and growth habits of blackberries propagated by hardwood cuttings. Blackberries are traditionally perennial plants that produce biennial canes. The first-year primocanes are vegetative, whereas the second-year floricanes are reproductive. We observed an interesting phenomenon of the blackberries growth habit that deviates from the traditional perennial plant/biennial cane system. We observed a morphological reversion of the floricanes cuttings to juvenile plants after the plants rooted and flowered. As anticipated, the majority of cuttings that rooted subsequently produced flowers. However, after flowering was completed the canes did not die as expected. The plants continued to live and produce new vigorous shoots. We observed lateral shoots developing from vegetative buds along canes, as well as new shoots originating from the base of the plants. In concept, propagating by hardwood cuttings has enabled a blackberry plant to complete efflorescence, and then revert to the vegetative growth period. These observations suggest that propagating blackberries from hardwood cuttings may be of significant value and that more research of blackberry hardwood propagation is warranted.

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Table 1. Interaction means for cutting diameter (mm) of blackberry cultivar and cutting location along canes.

Cultivar	Apical	Mid	Basal	Main effect of cv.
Apache	4.2aC ^{zy}	4.7bB	5.5cA	4.8b
Arapaho	4.2aC	5.5aB	6.3aA	5.3a
Navaho	4.1aC	4.9bB	5.8bA	4.9b
Main effect of location	4.2C	5.1B	5.9A	-

^z Means in columns followed by different lowercase letters are significantly different (P < 0.05).

^y Means in rows followed by different uppercase letters are significantly different (P < 0.05).

Table 2. Interaction means of blackberry cultivar by auxin treatment for percent rooting and root rating (1 to 5 rating with 5 = extensive root system) after 5 weeks.

Cultivar	Percent rooted		Main effect of cv.	Root rating		Main effect of cv.
	- Auxin	+ Auxin		- Auxin	+ Auxin	
Apache	38.1aA ^{zy}	47.6aA	42.8A	2.1bB	3.5aA	2.8a
Arapaho	47.5aA	14.2bB	30.9A	2.1bB	2.1bB	2.1b
Navaho	38.1aA	26.9bA	32.5A	2.6bB	4.2aA	3.4a
Main effect of auxin	41.3A	29.5B	-	2.3B	3.3A	-

^z Means in columns followed by different lowercase letters are significantly different (P < 0.05).

^y Means in rows followed by different uppercase letters are significantly different (P < 0.05).