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PROPAGATION OF THORNLESS BLACKBERRIES UTILIZING ADVENTITIOUS SHOOTS FROM ROOT CUTTINGS

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Abstract:

Studies were conducted in early 2003 to determine the effect of root source and length on yield of adventitious shoots from root cuttings and on subsequent plant yield for University of Arkansas-developed thornless blackberries. In the first study, roots from 'Arapaho' and 'Apache' plants grown in an aboveground bed containing commercial potting soil were compared to field-grown roots. Bed-grown roots averaged 6.9 shoots per 15 cm root cutting while field grown roots averaged 3.4. 'Apache' produced more shoots/root cutting compared to Arapaho, (5.9 vs. 4.4 shoots/root cutting, respectively). In a comparison of 15- vs. 30-cm-long root cuttings of 'Apache', 'Arapaho', and 'Ouachita', shoot yield of 30-cm roots was higher than that of 15 cm roots, but total yield of shoots per root unit was not increased by the longer root cuttings. Rooting of adventitious shoots neared 100% in both studies, and resulting quality of plants from these shoots was very good. This minor modification to the traditional method of planting root pieces to yield individual plants could lead to a more efficient and productive yield of propagules. The use of adventitious shoots from root cuttings for blackberry plant propagation appears to be a viable method for nurserymen to consider.

Introduction:

Traditional methods of blackberry (*Rubus* subgenus *Rubus* Watson) propagation include tip layering, softwood cuttings, root cuttings, and tissue culture (Caldwell, 1984). While all successful, some methods often require lengthy establishment and growing periods and often do not meet virus-tested stock demands when virus-tested stock plant material is limited or when propagation must be conducted in enclosed structures with very limited space. These methods are commonly used due to familiarity and cost efficiency, and generally the use of root cuttings is the most widely practiced type of propagation for Arkansas-developed cultivars (John R. Clark, personal communication). In general, Arkansas-developed blackberries are very successful under this method. However, a simple modification in the use of root cuttings could lead to a more efficient yield of propagules. The forcing of multiple adventitious shoots and subsequently rooting them to produce individual plants would allow propagators to yield more plants from a single root cutting. This method has been used in raspberry production as a successful means to increase propagule yield (Jennings, 1988). Also, a nursery in Switzerland that propagates and grows University of Arkansas-released cultivars has found this method to be efficient for both raspberries and blackberries (Markus Kobelt, Rhein-Baumschulen, Buchs, Switzerland, personal communication).

Cultivar and source of root cuttings have been regarded as possible reasons for variation in subsequent plant stand and quality. Observations involving bed-grown root cuttings indicated they varied in performance compared to field-grown root cuttings (Charles Boyd, Cedar Valley Nursery, Centralia, Wash.). Arkansas blackberry cultivars have been shown to vary in the percent sprouting of root cuttings (Clark and Moore, 1999), therefore, an evaluation of cultivar effects is needed in the evaluation of root cutting feasibility for plant production.

The objectives of our studies were to: 1) compare field-grown roots to soil-less, bed-grown roots in adventitious shoot production for two cultivars, and 2) determine if root cutting length affects resulting adventitious shoot number, plant size, and quality for three cultivars. Our intent is to provide this information to blackberry nurserymen as an alternative method to maximize propagation potential.

Materials and Method:

Experiment I: Cultivar and Root Source Study

Thirty field-grown roots of the thornless blackberry cultivar Arapaho were collected from the University of Arkansas Agricultural Research and Extension Center, Fayetteville. The same number of 'Apache' roots was collected from the University of Arkansas Fruit Substation, Clarksville, all in December, 2002. The diameter of the roots was measured and root pieces were cut to 15 cm and placed in sealed, moist plastic bags in cold storage at approx. 3∞C. The average diameter of the bed-grown roots was 2.4 mm while the field-grown roots averaged 4.7 mm. On 19 January 2003 (approximately one month of storage), the root cuttings were removed from storage and placed in drained,

plastic tubs containing PromixÆ soil-less potting mix (Sun-Gro Horticulture, Bellvue, Wash.) to a depth of 6 cm. The roots were maintained in the containers until mid-June. The containers were kept in a greenhouse with a daily minimum temperature of approx. 18∞C and a daily maximum temperature of approx. 25∞C. Roots were placed in the containers in a randomized complete block design of 10 replications, with three roots of each cultivar/root source per replication. Adventitious shoots were removed each 7-10 d as they emerged and length of shoots at removal was 3 to 5 cm. Harvested adventitious shoots were then stuck into JiffyÆ peat pellets (Jiffy Co., Batavia, Ill.) and placed under an intermittent mist system until rooted. Adventitious shoots generally rooted within 7 to 12 d. Up to 10 rooted shoots were then potted in 10 cm pots containing PromixÆ soil-less potting mix, maintained in the greenhouse, grown, and later evaluated for quality in May 2003. Each 0.8 cubic-meter bag of potting media received 50 mL of Osmocote 14-14-14 (The Scotts Co., Marysville, Ohio) per 0.03 cubic meter of soil for fertilization. Data collected included 1) date of adventitious shoot collection, 2) total number of adventitious shoots yielded, 3) plant establishment and survival percentage, and 4) overall resulting plant-quality rating from 1 to 5; 1 = excellent plant health and growth and 5 = poor plant health and growth.

Experiment II: Cultivar and Root Length Study

Field-grown roots of 'Arapaho' and 'Ouachita' were collected from the same Fayetteville location, and 'Apache' from Clarksville in December, 2002. Roots of each cultivar were cut into lengths of 15 and 30 cm and placed in plastic containers in soil-less medium as described in Study I. Roots were also evaluated for quality in May and all roots were maintained in the containers until mid-June. Roots and harvested adventitious shoots received the same greenhouse treatments as in Experiment I. The study was arranged as a randomized complete block design with four replications of each treatment combination, with three roots of each cultivar and length per replication. Data collected were the same as in Experiment I.

Data for both studies for shoot yield, plant survival, and plant quality were analyzed by analysis of variance using JMP (JMP, version 4, SAS Institute Inc. Cary, N.C.) and treatment means were compared using t-tests ($P<0.05$).

Results:

Experiment I:

There were significant effects for root source and cultivar for adventitious shoot production per root cutting, but not for the interaction of root source and cultivar. 'Apache' averaged 5.9 adventitious shoots per root, compared to 'Arapaho' with 4.4 (Table 1). This observation agrees with a study by Clark and Moore (1999), in which adventitious shoot yield from 'Apache' root cuttings was higher than that of 'Arapaho.' Bed-grown roots produced on average 6.9 adventitious shoots per root, significantly greater than field-grown roots, which averaged only 3.4 adventitious shoots per root (Table 1). Adventitious root collection began approximately 4 weeks after placement of the roots in the medium. Overall, adventitious shoot harvest was greatest in the first 7 weeks of study after first-shoot emergence, but was greatly reduced thereafter (Fig.1). For bed-grown roots, there was a tendency for earlier shoot development and subsequent adventitious shoot harvest particularly in the first 2 weeks after first emergence. Eleven weeks after initial planting of roots, 75% of 'Apache' and 72% of 'Arapaho' bed-grown shoots had been harvested. Field-grown adventitious shoot yield was also greatest in the first 11 weeks of the study, however in comparison to bed-grown sources, shoot development in field-grown sources was somewhat delayed. Adventitious shoot yield fell off greatly after the first 11 weeks after initial root planting for both bed-grown and field-grown sources (Fig. 1).

The percent survival for the adventitious shoots upon removal from the root cuttings and placement under mist neared 100% (data not shown), indicating near complete success of rooting and subsequent plant survival using this method. Once potted, the plants grew vigorously and did not show any signs of nutrient deficiencies or further weaknesses. Quality ratings on resulting potted plants indicated excellent performance and there were no differences among cultivars or root sources (data not shown).

Experiment II:

There were significant effects for root length but not cultivar in this study and the interaction of root length and cultivar was not significant. Root length of 30 cm for all three cultivars yielded a mean of 6.1 adventitious shoots per root, while the average for 15-cm roots for the three cultivars was 3.4 adventitious shoots per root (Table 2). The overall plant yield, in a practical sense, was not different in that longer roots simply yielded about the same number of adventitious shoots as did two of the shorter roots. Similar to Experiment I, adventitious shoot harvest was greatest in the first 11 weeks of the study and did not appear to be affected by root length or cultivar (data not shown). Cultivars showed small numerical differences in shoot number, but none were significant. Plant quality ratings showed slight numerical differences for root length and cultivar, but none were significant (data not shown). Overall plant quality was very good for all cultivars and root lengths.

Discussion:

The major objective of our studies was to determine if propagation of thornless blackberries utilizing adventitious shoots from root cuttings proved to be a more efficient and higher yielding method than the traditional root-cutting propagation commonly used in the industry. We were equally interested in ensuring that plant quality, using this propagation method, is as good as that produced from other, more traditional methods. The survivability of plants using this method was excellent. Once the

adventitious shoots rooted and were potted, they grew vigorously and could quickly be grown into a marketable plant. This finding could be particularly valuable to a nurseryman.

Using this method, the amount of root material needed for an increased number of plants yielded per root would be much less than the more common yield of one plant per root cutting. This could be of particular value if, for instance, nurserymen grew plants for root cuttings in enclosed structures, such as beds in screenhouses that excluded virus vectors, and subsequently used the roots to force adventitious shoots. Growers using this method could expect significantly higher adventitious shoot production in the thornless cultivar 'Apache', although this method is also useful for the other cultivars. Growers could also expect to double adventitious shoot yields if bed-grown roots were used. It is possible that field-grown roots become more lignified, therefore yields are less due to lack of undifferentiated root cells.

Further studies on this topic might include the evaluation of rooting hormone on adventitious shoot production. Evaluating the use of shorter bed-grown roots in greater quantities and comparing the resulting number of adventitious shoots may result in an even greater yield of propagules.

The University of Arkansas released the first commercial primocane-fruiting blackberry cultivar in early 2004. These unique plants, which produce fruit on current-season canes (primocanes), rather than overwintered, 2-year-old canes (floricanes), will likely be limited to only tissue culture or root-cutting propagation. Softwood-cutting propagation will likely not be feasible due to primocane morphology being immediately in flowering mode rather than vegetative mode during the growing season. The use of adventitious shoots emerging from longer root cuttings could be a valuable method of propagating these new cultivars, in that these small shoots will be vegetative in growth and not in the flowering mode at this juvenile stage. Further evaluation of this technique will reveal the potential of this method with these unique plants.

Literature Cited:

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Editor's Note:

This paper was selected from the papers published by the Bumpers College of Agriculture journal by its editor for inclusion in *Inquiry*.

Table 1. Number of adventitious shoots per root resulting from bed- and field-grown roots of 'Apache' and 'Arapaho' blackberries.

Cultivar	Bed-grown	Field-grown	Cultivar main effects
Apache	8.0	3.8	5.9a[z]
Arapaho	5.8	2.9	4.4b
Root source main effects	6.9 A[z]	3.4 B	

z Upper case letters represent a significant main-effect difference for root source; lower case letters represent a significant difference for cultivar ($P<0.05$). The interaction of cultivar by root source was not significant in the data analysis.

Table 2. Number of adventitious shoots per root at two root lengths among three cultivars.

	Root length		
Cultivar	15 cm	30 cm	Cultivar main effects
Apache	2.5	5.8	4.2
Arapaho	4.6	5.3	5.0
Ouachita	3.1	7.2	5.2
Root length main effects	3.4 A[z]	6.1 B	

[z]Upper case letters represent a significant difference among root lengths, ($P<0.05$).

Fig. 1. Dates of adventitious shoot collection from 'Arapaho' and 'Apache' blackberry roots from bed- (BG) or field-grown (FG) sources.