Title: Increasing lateral branching of blackberry with 6-benzyladenine and GA_3

Principal Investigator(s):

Thomas M. Kon, Assistant Professor, Department of Horticultural Science, North Carolina State University, Mountain Horticultural Crops Research and Extension Center, 455 Research Drive, Mills River, NC 28759; tom_kon@ncsu.edu

Gina Fernandez, Professor, Department of Horticultural Science, North Carolina State University, Department of Horticultural Science, Campus Box 7609, Raleigh, NC 27695; gina_fernandez@ncsu.edu

Public Abstract:

Inadequate lateral branch development can have negative consequences on blackberry productivity and profitability, since yield is positively correlated with lateral branch number. Growth management of blackberry by commercial growers generally relies on summer pruning/tipping at multiple heights throughout the growing season. Tipping is a labor intensive and expensive process (~$600 per acre) that increases risk of cane blight infection. We investigated the use of 6-benzyladenine and GA_3 (6-BA + GA_3) to induce lateral branching of blackberry. To determine an optimal concentration of 6-BA + GA_3 we evaluated a range of concentrations on 'Ouachita' blackberry. In general, there was no relationship with 6-BA + GA_3 concentration and measured responses of primocane growth and development. As rates 6-BA + GA_3 increased, we observed a linear reduction in yield. Alternative approaches for lateral branch development of blackberry requires further investigation; however, use of 6-BA + GA_3 was ineffective in this particular trial under a wide range of concentrations (0 to 800 ppm).

Introduction

Inadequate lateral branch development can have negative consequences on blackberry productivity and profitability, since yield is positively correlated with lateral branch number (Strik et al., 2012). Growth management of blackberry by commercial growers relies on summer pruning/tipping at multiple heights throughout the growing season. Tipping can increase lateral branch development, bearing surface, and subsequent yields (Fernandez et al., 2016; Strik et al., 2012). However, tipping is a labor intensive and expensive process (~$600 per acre) that increases risk of cane blight infection. Cane blight (caused by *Leptosphaeria coniothyrium)* can result in mortality of fruiting canes and/or severe economic losses in the southeastern US (Brannen and Krewer, 2012).

Methods to promote lateral branching are well developed in tree fruit production (Cowgill et al., 2017). Application(s) of a cytokinin (6-BA; 6-benzyladenine) and/or gibberellins (GA3 or GA4+7) are effective in enhancing apple lateral branch development. In 2018, PI's Kon and Fernandez evaluated a mixture of 6-BA and GA_{4+7} to induce lateral branching of 'Traveler' however, this treatment was ineffective, even at relatively high concentrations (data not shown). However, Malik and Archbold (1992) demonstrated that lateral branch number and length was increased with 100 ppm 6-BA + GA3. To our knowledge, this is the only report of 6-BA + GA_3 effects on lateral branch development of blackberry.

If effective, chemical management of blackberry growth could reduce: 1) labor inputs associated with manual summer pruning/tipping, 2) incidence of cane blight due to manual summer pruning, and 3) the number of fungicide applications for managing cane blight.

Materials and Methods

In 2021, we initiated an experiment in a three-year-old 'Ouachita' blackberry planting at NC State University's Mountain Horticultural Crops Research and Extension Center in Mills River, NC. The planting was established in 2019 at 4' x 12' spacing. Twenty-four uniform three-plant plots were selected and flagged (12 plots per treatment). The following treatments were evaluated: 1) untreated control, 2) 50 ppm 6-BA + GA_3, 3) 100 ppm 6-BA + GA_3, 4) 200 ppm 6-BA + GA_3, 5) 400 ppm 6-BA + GA_3, 6) 800 ppm 6-BA + GA_3. Treatments were applied a CO_2 sprayer at ~3 week intervals, until flower bud development was observed.

Primocane height was measured at ~3 week intervals throughout the growing season. When fruit reached a commercially acceptable level of maturity, plots were harvested twice per week for a six-week period. Cumulative yield, marketable yield, unmarketable yield, and average fruit weight was determined. Unmarketable fruit (culls) were classified as fruit that were damaged, deformed, or over-mature. Across twelve harvest dates (where applicable), a 25 berry subsample was randomly selected from each plot and weighed to estimate average fruit weight.

A morphometric characterization of three primocanes per plot occurred. After harvest, canes were cut at the base and moved to the lab for analysis. Basal cane cross-sectional area was determined, and the number of laterals per cane were counted. On each lateral, nodes were counted and length were measured. Fresh and dry weight of each tissue type (cane and laterals) were determined.

The experiment had a completely randomized design with four replications to evaluate the relationship between 6-BA + GA_3 concentrations and measured responses. The PC version of SAS (version 9.4; SAS Institute, Cary, NC) was used to carry out all statistical analysis. Regression analysis was performed using PROC GLM at $P = 0.05$.

Results and Discussion

There was no relationship between 6-BA + GA_3 concentration and primocane height (Table 1). 6-BA + GA_3 concentration did not influence any measured response in the morphometric characterization of primocanes (Table 2).

Total yield, marketable yield and cull yield was reduced as 6-BA + GA_3 concentration increased. There was no relationship between 6-BA + GA_3 concentration and average fruit weight (Table 3).

While 6-BA + GA_3 showed promise as an alternative to increase lateral branch number (Malik and Archbold 1992), we did not observe a positive impact on lateral branching and yield.

Data from this trial did not accord with Malik and Archbold (1992). Continued evaluation of chemical and/or cultural practices to enhance lateral branch development and reproductive potential should occur. Future studies should focus on identifying factors that limit lateral branch development in blackberry, as typical branch induction strategies utilized in other Rosaceous cropping systems have not been broadly applicable.

Table 1. Effects of 6-BA + GA3 on floricane and lateral development

Treatment	Rate of 6-BA + GA3	Final Cane Length (cm)	Cane Circ. (cm)	Nodes per cane	Internodal Length (cm)	Lateral branch #	Lateral branch Lngth (cm)	Lateral branch Node #	Total Linear Surface Area	Cane Fresh Wt (kg)	Lateral Fresh Wt (kg)	Cane Dry Weight (kg)	Lateral Cane Dry Weight (kg)
1	0	274.35	5.92	40.60	6.77	8.30	690.95	141.10	865.60	0.834	0.464	0.469	0.243
2	50	303.63	5.94	48.09	6.35	8.91	533.35	131.55	836.98	0.917	0.382	0.508	0.197
3	100	305.20	5.89	44.92	6.96	9.75	573.23	133.75	878.43	0.964	0.449	0.550	0.230
4	200	322.33	5.70	50.83	6.41	10.00	549.21	129.92	871.53	0.979	0.412	0.570	0.220
5	400	298.17	6.16	43.10	7.16	7.70	441.07	104.50	739.24	1.051	0.337	0.604	0.185
6	800	324.35	6.28	48.33	6.78	7.83	428.96	102.83	753.31	1.108	0.340	0.702	0.184
Significance													
Rate	P value (L)	0.1543	0.2611	0.3957	0.8068	0.4224	0.1751	0.1897	0.3147	0.1801	0.4061	0.0729	0.505
	P value (Q)	0.2453	0.5388	0.5491	0.9706	0.6874	0.3771	0.4193	0.5974	0.3683	0.6773	0.2012	0.7841

[z]Means of four observations.

[y] L = linear model; Q = quadratic model.

Table 2. Effects of 6-BA + GA3 on floricane height

Treatment	Rate of 6-BA + GA3 (ppm)	Average height 155 Julian Days	Average height 175 Julian Days	Average height 193 Julian Days	Average height 290 Julian Days
1	0	144.00	211.83	253.33	261.17
2	50	150.42	237.08	280.17	306.79
3	100	151.67	231.67	282.63	305.20
4	200	138.17	225.63	293.29	323.68
5	400	140.17	230.25	285.13	306.64
6	800	157.17	248.67	309.08	324.35
Significance					
Rate	P value (L)	0.5727	0.1469	0.0591	0.1552
	P value (Q)	0.5308	0.3527	0.1549	0.2404

[z]Means of four observations.

[y] L = linear model; Q = quadratic model.

Table 3. Effects of 6-BA + GA3 on Fruit yield and Average fruit weight

Treatment	6-BA + GA3	Total Yield (kg)	Marketable Yield (kg)	Cull Weight (kg)	Avg Fruit Weight (kg)
1	0	4.744	3.124	1.621	0.008
2	50	3.239	2.083	1.156	0.007
3	100	3.354	2.179	1.174	0.016
4	200	2.733	1.718	1.016	0.019
5	400	3.374	2.344	1.031	0.008
6	800	2.217	1.354	0.864	0.007
Significance					
Rate	P value (L)	0.0227	0.0404	0.0105	0.5392
	r^2	0.214334	0.177412	0.262527	0.017374
	P value (Q)	0.0649	0.1227	0.0141	0.5784
	r^2	0.229296	0.181095	0.333677	0.0508

[z]Means of four observations.

[y] L = linear model; Q = quadratic model.

References:

Brannen, P.M. and G.W. Krewer. 2012. Cane blight of blackberry. University of Georgia Cooperative Extension. Circular 894.

Cowgill, W., J. Clements, and W. Autio. 2017. Branching young apple trees with plant growth regulators. UMass Extension Fruit Publications. F-140. https://ag.umass.edu/sites/ag.umass.edu/files/fact-sheets/pdf/f-140_ _branching_young_apple_trees.pdf

Fernandez, G.E., E. Garcia, and D. Lockwood. 2016. Southeast Caneberry Production Guide. Southern Region Small Fruit Consortium. NC Cooperative Extension Service. AG-697. https://rubus.ces.ncsu.edu/spotlight/caneberry-production-guide/.

Malik, H. and D.D. Archbold. 1992. Manipulating primocane architecture in thornless blackberry with uniconazole, GA3, and BA. HortScience 27(2):116-118.

Strik, B.C., J.R. Clark, C.E. Finn, and G. Buller. 2012. Management of primocane-fruiting blackberry: impacts on yield, fruiting season, and cane architecture. HortScience 47(5):593-598.