

Effect of In-Row Spacing and Early Cropping on Yield and Dry Weight Partitioning of Three Highbush Blueberry Cultivars the First Two Years After Planting

Bernadine Strik
Gil Buller

SUMMARY. The effect of early cropping (no blossom removal the first two years) and in-row spacing at 0.45 m and 1.2 m (1.5 ft and 4 ft) are being studied in 'Duke', 'Bluecrop', and 'Elliott' blueberries (*Vaccinium corymbosum* L.) planted in October 1999. No yield was produced on the non-cropped plants in 2000 and 2001. In the early-cropped treatments, yield at 0.45 m was about three times that at 1.2 m in all cultivars in 2000 and 2001. 'Duke' and 'Elliott' produced the highest yield in 2000. In 2001, yield increased 8 to 16 fold at the 0.45 m spacing, depending on

Bernadine Strik is Professor and Gil Buller is Research Assistant, Department of Horticulture and the North Willamette Research and Extension Center, Oregon State University, 4017 ALS, Corvallis, OR 97331-7304 (E-mail: strikb@science.oregonstate.edu).

The authors appreciate the financial support of the Oregon Blueberry Commission and the Northwest Center for Small Fruits Research and the assistance from Fall Creek Farm and Nursery with plant costs.

[Haworth co-indexing entry note]: "Effect of In-Row Spacing and Early Cropping on Yield and Dry Weight Partitioning of Three Highbush Blueberry Cultivars the First Two Years After Planting." Strik, Bernadine, and Gil Buller. Co-published simultaneously in *Small Fruits Review* (Food Products Press, an imprint of The Haworth Press, Inc.) Vol. 3, No. 1/2, 2004, pp. 141-147; and: *Proceedings of the Ninth North American Blueberry Research and Extension Workers Conference* (ed: Charles F. Fomey, and Leonard J. Eaton) Food Products Press, an imprint of The Haworth Press, Inc., 2004, pp. 141-147. Single or multiple copies of this article are available for a fee from The Haworth Document Delivery Service [1-800-HAWORTH, 9:00 a.m. - 5:00 p.m. (EST), E-mail address: docdelivery@haworthpress.com].

<http://www.haworthpress.com/web/SFR>

© 2004 by The Haworth Press, Inc. All rights reserved.

Digital Object Identifier: 10.1300/J301v03n01_14

141

cultivar. Pruning weight per plant was affected by cultivar, in-row spacing, and early cropping. In winter 2000/01, after one year of early cropping, there was no treatment effect on the percentage of fruit buds per lateral. However, in winter 2001/02, early-cropped plants had a lower percentage of fruit buds in 'Bluecrop' and 'Duke' than plants that were not cropped early. Plants spaced at 0.45 m also had a lower percentage of fruit buds than those at 1.2 m in 'Duke' and 'Elliott'. Total plant dry weight in winter 2001/02 was affected by cultivar and early-cropping. Early cropping reduced plant size in all cultivars. [Article copies available for a fee from The Haworth Document Delivery Service: 1-800-HAWORTH. E-mail address: <docdelivery@haworthpress.com> Website: <<http://www.HaworthPress.com>> © 2004 by The Haworth Press, Inc. All rights reserved.]

KEYWORDS. Pruning, growth, berry size, planting

INTRODUCTION

Blueberry production has been increasing steadily in Oregon and Washington with approximately 80 to 120 ha (200 to 300 acres) being planted per year, on average, over the last ten years. Growers have been following recommendations (Pritts and Hancock, 1992; Strik et al., 1993) in removing blossom buds the first two years after planting. This standard procedure is thought to be necessary to promote good root and vegetative growth. However, preliminary findings in *Vaccinium corymbosum* L. 'Bluecrop' showed that cropping plants the first two years, actually increased production in years three through eight 18% compared to plants that were not cropped early (Strik, unpublished). It is not known how other cultivars would respond to early cropping. If growers were able to crop plants early (in years one and two), then they would not only derive some income from the fruit, but would save an estimated \$125-\$250/ha (\$50-\$100/acre) in not having to prune off the blossom buds.

Most of the mature acreage in Oregon and Washington is spaced at 1.2 m (4 ft) in the row with 3 m (10 ft) between rows. However, growers are tending now to establish plantings at higher density, particularly at 0.76 to 0.91 m (30 inches to 3 ft) in the row based, in part, on research done by Strik and Buller (2002). Moore et al. (1993), in a five-year spacing study with 'Bluecrop' and 'Blueray', found no differences between cultivars and that yield was highest at the 0.6 m (2 ft) spacing. Plants were not cropped early in his study. Strik and Buller (2002)

found that cumulative yield of 'Bluecrop' from years three through seven was 104% higher at a 0.45 m (1.5 ft) than at 1.2 m (4 ft) spacing. Early cropping in combination with higher planting densities could mean faster economic returns for highbush blueberry growers.

The objectives of this study were to determine the effect of early cropping and in-row spacing on yield and dry-weight partitioning of 'Bluecrop', 'Duke', and 'Elliott'.

MATERIALS AND METHODS

The research planting was established at the North Willamette Research and Extension Center (NWREC) in Aurora, Oregon in October 1999. The planting site was fumigated with methyl bromide/chloropicrin with sawdust and fertilizer incorporated and raised beds formed prior to planting two-year-old container stock. The treatments were: cultivar (Duke, Bluecrop, Elliott); in-row spacing (0.45 m, 1.2 m [1.5 ft, 4 ft]); and early cropping (with or without blossom bud removal). In the no early crop treatments, blossom buds were pruned off the plants in October 1999 and in February 2001 in addition to standard pruning of young plants (Strik et al., 1990) to have no crop in 2000 and 2001. The early-cropped plants were not pruned in winter 1999/00 and 2000/01 other than to remove any diseased wood or very low growth. There were five replicates of each treatment combination arranged in a randomized complete block design for a total of 60 plots. Each plot was 6 m (20 ft) long (with 13 or 5 plants per plot at the 0.45 or 1.2 m spacing, respectively). The planting was flanked by guard rows.

Data collected included yield and picking time per harvest per plot, average berry weight (25 berries per harvest), pruning weight, cane number and age distribution, and percent fruit bud set (2000/01 and 2001/02). In February 2002, one plant per plot was destructively harvested and divided into its parts and dry weights obtained.

The results presented here are for the first two years of harvests (early crop treatments only) and the dry weight data in 2002.

RESULTS AND DISCUSSION

Total yield, berry weight, and hand picking efficiency in 2000 and 2001 were significantly affected by cultivar and in-row spacing. There was no cultivar by spacing interaction. However, data are presented by

cultivar here for ease of interpretation. 'Duke' and 'Elliott' had the highest yield in year one, whereas 'Bluecrop' and 'Elliott' had the highest yield in year two (Table 1).

Yield at the 0.45 m spacing was about three times the yield of the 1.2 m spaced plots in all cultivars the year after planting, 2000, and in 2001 (Table 1). Although yield at the traditional 1.2 m spacing only averaged 403 g/plot (580 lb/acre) the first year after planting (2000), yield increased to an average of 4 kg/plot (1,915 lb/acre) in 2001 (Table 1). Yield for plants spaced at 45cm in the row averaged 12.1 kg/plot (5,851 lb/acre) in 2001 (Table 1). Yield of 'Bluecrop' in this study in year one was similar to what we observed in our preliminary early-cropping study (Strik, unpublished). However, yield in this study was 2.5 to 6.5 times higher in year two than in our earlier study. This may have been a result of our earlier planting being on flat ground in heavy soil whereas this planting was established on raised beds and plants were observed to be more vigorous in this study.

Berry weight was significantly higher at the closer in-row spacing in both years. In-row spacing had inconsistent effects on berry weight of 'Bluecrop' in an earlier study done by Strik and Buller (2002). 'Elliott' tended to have the lowest picking efficiency (Table 1).

TABLE 1. The effect of in-row spacing and cultivar on total yield, berry weight, and picking efficiency of early-cropped plants in 2000 and 2001. Plants were established in October 1999.

Treatment	Total Yield (g/plot)		Berry Weight (g)		Picking Efficiency (g/min)	
	2000	2001	2000	2001	2000	2001
Duke						
0.45 m	1243	9729	1.16	1.66	73	111
1.2 m	431	3097	1.14	1.58	74	100
Bluecrop						
0.45 m	852	13587	2.08	1.56	130	81
1.2 m	305	4103	1.94	1.38	113	68
Elliott						
0.45 m	1192	13075	1.44	0.98	85	50
1.2 m	474	4774	1.30	0.96	78	39
Significance^z						
Cultivar	***	***	***	***	***	***
Spacing	***	***	*	*	NS	**
Cult. × Space	NS	NS	NS	NS	NS	NS

^z NS, *, **, *** = non-significant or significant at P < 0.05, 0.01 or 0.001, respectively

There was no effect of in-row spacing on the number of one-, two- or three-year-old canes per plant (data not shown). Pruning (crop or no crop) affected the number of three-year-old canes per plant, as only the early-cropped plants had older canes (data not shown).

In winter 2000/01, after one year of early cropping, there was no effect of cultivar, spacing, or early cropping on the percentage of fruit buds per lateral (data not shown). However, in winter 2002, plants that were cropped early had a lower percentage of fruit buds in 'Bluecrop' and 'Duke' (Table 2). Plants spaced at 1.2 m in the row had a higher percentage of fruit buds in 'Duke' and 'Elliott'. 'Duke' had the highest percentage of fruit buds, averaging 63.5% compared to 58.1% and 45.8% in 'Elliott' and 'Bluecrop', respectively (Table 2).

Early cropping had no significant effect on pruning weight per plant in winter 2002 (Table 3). Plants at 1.2 m had a higher pruning weight than those at 0.45 m, particularly in 'Elliott' (Table 3).

Total plant dry weight, including roots (after pruning in 2002) was significantly affected by cultivar ($P < 0.001$) and early cropping ($P < 0.001$), but not in-row spacing. Plants that were not cropped early had significantly larger root systems and more one-, two-, and three-year-old wood and crowns than plants that were cropped early (Figure 1). 'Bluecrop' plants were smaller than those of 'Duke' and 'Elliott' in the early cropped and no crop systems (Figure 1). Roots accounted for 31% to 58% of the total plant dry weight depending on cultivar and early cropping.

CONCLUSIONS

Young plants spaced at high density (0.45 m; 1.5 ft) compared to the more traditional spacing of 1.2 m (4 ft) produced about three times the

TABLE 2. Effect of cultivar, plant spacing, and early cropping on percent fruit buds (%) on one-year-old wood in winter 2002. Plants were established in October 1999.

Plant Spacing	Bluecrop		Duke		Elliott	
	No crop	Early crop	No crop	Early crop	No crop	Early crop
0.45 m	50.1	41.2	63.8	55.6	52.6	55.0
1.2 m	51.6	40.3	69.2	65.5	61.7	62.9
Significance ²	Cultivar: ***; Spacing: **; Early Cropping: *; Cultivar × Spacing: NS; Cultivar × Pruning: *; Spacing × Pruning: NS; Cultivar × Spacing × Pruning: NS					

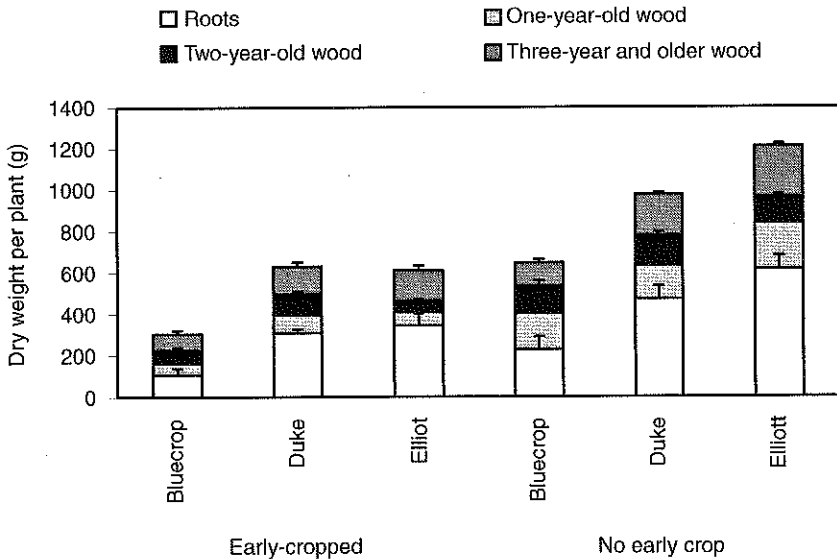
² NS, *, **, *** = non-significant or significant at $P < 0.05$, 0.01 or 0.001, respectively

TABLE 3. Effect of cultivar, plant spacing and early cropping on pruning weight per plant (g) in winter 2002. Plants were established in October 1999.

Plant Spacing	Bluecrop		Duke		Elliott	
	No crop	Early crop	No crop	Early crop	No crop	Early crop
0.45 m	130.2	146.8	157.2	120.5	156.2	169.9
1.2 m	142.5	151.6	175.3	161.6	245.5	256.5
Significance ^z	Cultivar: ***; Spacing: ***; Early Cropping: NS; Cultivar × Spacing: **; Cultivar × Pruning: NS; Spacing × Pruning: NS; Cultivar × Spacing × Pruning: NS					

^z NS, *, **, *** = non-significant or significant at $P < 0.05$, 0.01 or 0.001 , respectively

FIGURE 1. The effect of cultivar and early-cropping (the first two years after planting) on plant dry weight (roots, one-year-old wood, two-year-old wood, and crown + three-year-old and older wood) in February 2002. Averaged over in-row plant spacing.



yield in this study for all cultivars. Our results on the effect of in-row spacing on yield are similar to those reported by Strik and Buller (2002) in 'Bluecrop'. Early cropping produced economical yields, particularly in year two (averaging 5,851 lb/acre). However, early cropping seemed to "stress" plants as evidenced by a reduced total plant dry weight after

year two. In particular, the weight of the root system was reduced by 42% by early cropping, averaged over all cultivars and in-row spacing. The impact of this on yield of all treatments will be measured in year three as this study continues.

GROWER BENEFITS

Early cropping, particularly at a high planting density, could provide a significant source of income for growers. For example, in 'Duke', cumulative yield in years one and two was 5,792 kg/ha (5,265 lb/acre); at \$1.10/kg this would be a gross income of \$6,370/ha. However, early cropping was shown to reduce plant size including the amount of roots and one-year-old fruiting wood. At this point it is not known what impact this will have on yield in year three when we will compare early-cropped plants to those that had blossoms removed.

LITERATURE CITED

- Moore, J.N., M.V. Brown, and B.P. Bordelon. 1993. Yield and fruit size of 'Bluecrop' and 'Blueray' highbush blueberries at three plant spacings. *HortScience* 28:1162-1163.
- Pritts, M.P. and J.F. Hancock (eds.) 1992. Highbush blueberry production guide, NRAES-55, Ithaca, NY.
- Strik, B., D. Brazelton, and R. Penhallegon. 1990. Grower's guide to pruning highbush blueberries. Oregon State University Extension Service Video, VTP002, Corvallis, OR.
- Strik, B., C. Brun, M. Ahmedullah, A. Antonelli, L. Askham, D. Barney, P. Bristow, G. Fisher, J. Hart, D. Havens, R. Ingham, D. Kaufman, R. Penhallegon, J. Pscheidt, B. Scheer, C. Shanks, and R. William. 1993. Highbush blueberry production. Oregon State University Extension Service Publication, PNW215, Corvallis, OR.
- Strik, B. and G. Buller. 2002. Improving yield and machine harvest efficiency of 'Bluecrop' through high-density planting and trellising. *Acta Hort.* 574:227-231.