IMPROVING YIELD AND MACHINE HARVEST EFFICIENCY OF 'BLUECROP' THROUGH HIGH DENSITY PLANTING AND TRELLISING

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Abstract:

In-row spacing treatments of 45cm, 91cm, 1.2m, and 1.5m (1.5', 3', 4', and 5', respectively), with or without trellising, are being compared in a 'Bluecrop' planting established at the North Willamette Research and Extension Center, Aurora, Oregon in October, 1993. Plots were hand harvested from 1994-96 and machine harvested with an over-the-row Littau rotary machine from 1997-00. Machine harvest efficiency was determined from yield of machine-harvested fruit and drop loss that was collected from the ground and weighed. Yield increased with higher density plantings in 1996-00. Cumulative yield (1996-00) was 104% higher at the 45cm spacing (76.1 t/ha; 34.0 t/a) than the 1.2m spacing (37.4 t/ha; 16.7 t/a). In-row spacing had no effect on berry weight from 1994-1998. However, in 1999 higher density plantings had 10% heavier berries than plantings at 1.2m. In contrast, plants spaced at 1.2m produced berries that were 12% larger than those at the 45cm spacing in 2000. High-density plantings (45cm) took an average of 73% longer to prune than the standard 4' spacing from 1995-1999. In-row spacing, to date, has had no effect on machine harvest efficiency. Yield losses to machine harvest averaged 21% in 1997 and 24% and 22% in un-trellised plots in 1998 and 1999, respectively. Trellising had no effect on machine harvest efficiency in 1997. However, from 1998-00, trellising improved machine harvest efficiency by reducing losses by 4.3%, 7.8%, and 3.1% of total yield, respectively.

1. Introduction

In the Pacific Northwest, the traditional in-row plant spacing of 1.5m with 3m between rows has changed to a prevelance of plantings that are spaced at 1.2m x 3m. However, many growers are planting at a closer in-row spacing with 76 to 91cm being quite common. The main objectives to planting at these higher densities are to increase short-term productivity and improve efficiency of machine harvest by developing a "hedgerow" planting. However, there are no data on short- or long-term effects of a close in-row spacing on productivity. Eck (1988) suggests the possibility of planting at a 60cm spacing to improve

short-term productivity and then removing every other plant when interplant competition decreases yield. It is not known whether this would be necessary, nor whether it would be possible without damaging remaining plants.

Many growers are trellising plantings to keep branches heavily laden with fruit narrow enough to fit the throat of the over-the-row machine harvesters used. There is no evidence to show beneficial effects of trellising. Also, trellising may decrease light exposure to the center of the bush, thus decreasing fruitfulness of the interior wood (Eck and Stretch, 1986).

Moore *et al.* (1994) recently published findings on a five-year spacing study in 'Bluecrop' and 'Blueray'. No differences were found between cultivars. Yield per hectare was highest with the closest spacing (60cm), but yield per plant was highest at the 1.2m spacing, after five years. Trellising and machine harvest efficiency effects were not studied and conditions in the Pacific Northwest are likely to be different, as plants are more vigorous and productive here.

The objectives of our study are to determine the effect of in-row spacing and trellising on short- and long-term yield and machine harvest efficiency of 'Bluecrop'. The findings presented here are preliminary, as work is in progress.

2. Materials and Methods:

This study was conducted in a planting of 'Bluecrop' established at the North Willamette Research & Extension Center, Aurora, Oregon in October 1993. The site was fumigated and sawdust and nitrogen were incorporated prior to planting the two-year-old “grow bag” plants. The experimental design is a split plot with five replicates. Trellising is the main effect (a trellis or no trellis) with the trellis consisting of wooden end posts with metal posts in the row spaced at 6m. Two wires, one on each side of the plant are positioned at a height of about 90cm from the ground. The sub-plot in-row spacing treatments are as follows: 45cm; 91cm; 1.2m; and 1.5m. Each treatment plot is 6m long. Adjacent plots are separated by 3m so that the machine can be stopped to allow the machine-harvested fruit to clear the belts before moving on to the next plot. Row spacing is 3m and guard rows flank the planting. A support structure for overhead net for bird protection was in place from 1996-1997. Plots were protected from bird depredation from 1998-00 using bird alarms and other scare devices.

Blossoms were removed the first two years after planting. Plots were hand harvested from 1994-96 and were machine harvested from 1997-2000. The machine harvester used was a Littau over-the-row free-wheeling, horizontal action rotary (Littau Harvesters Inc., Stayton, Ore., USA). Machine harvest efficiency was determined from yield of machine-harvested fruit and drop loss. Drop was collected and weighed from an area equal to two times the in-row spacing distance. Data on the area of the bush at the height of the machine harvester catcher plates were collected from 1999-2000 for each plot. Data on total yield and fruit weight (average of 25 berries per harvest date) were collected. A seasonal weighted average

berry weight was calculated. After final machine harvest, the remaining fruit from one plant per plot was harvested by hand to determine the amount of yield that could not be picked by machine.

Plots were being pruned annually with pruning weights and times per treatment recorded.

3. Results and Discussion:

3.1 In-row spacing

Yield increased with higher density plantings in 1996-00 (Figure 1). The higher yield per plant at the wider spacing (data not shown; 3.52 kg/plant at 4'; 2.06 kg/plant at 1.5' in 2000, for example) was not enough to compensate for a lower plant number/area.

The 45cm spacing had a 100% greater yield (double) in 1996, 70% in 1997, 103% in 1998, 108% in 1999, but only 84% in 2000 (Figure 1). Yield was lower in 2000 than we would expect for a seven-year-old planting of 'Bluecrop'. We feel that this was most related to insufficient irrigation in 2000. Due to limitations on water availability, plots were only irrigated with 2.5cm of water per week during a growing season in which there was no rainfall from June 15 through September, 2000 (data not shown). However, the yield reduction at the 45cm spacing from 1999 to 2000 was 18%, whereas at the 1.2m spacing there was only a 7% reduction in yield from 1999 to 2000 (Figure 1). In this same time period, yield per plant decreased approximately 0.3 kg for both treatments when we would have expected yield to increase as plants were maturing (from 2.37 kg to 2.06kg/plant at 45cm; from 3.86 to 3.52kg/plant at 1.2m). Thus, on a per area basis, there was a much larger yield reduction at the high-density spacing (Figure 1). This was either due to increased plant competition leading to lower yield in more mature plantings at the high density, regardless of drought stress, or it was simply a reflection of greater drought stress at the 45cm spacing. We will not know the answer to this question without collecting data for another year or more ensuring that no drought stress occurs.

Despite the lower than expected yields, cumulative yield (1996-00) was 104% higher at the 45cm spacing (76.1 t/ha; 34.0 t/a) than the 1.2m spacing (37.4 t/ha; 16.7 t/a). Cumulative yield at the 91cm spacing was 50% greater than at the 1.2m spacing (data not shown).

In-row spacing had no effect on berry weight from 1994-1998. However, in 1999 berries were 10% heavier at 45cm than at the 1.2m spacing ($P<0.05$; Figure 2). In contrast, plants spaced at 1.2m produced berries that were 12% heavier than at the 45cm spacing in 2000 ($P<0.0001$; Figure 2). This may have been a reflection of greater drought stress at the high density spacing in 2000.

In-row spacing has had no effect on percent of total yield lost on the ground during machine harvest to date (Figure 3). Therefore, growing plants at high density with narrow crowns in a "hedgerow" (45cm spacing), has not improved machine harvest efficiency, despite the bush area at plate height being 23-28% smaller at the 45cm than the 1.2m spacing (1999-00, data not shown). Losses to machine harvest in un-trellised plots averaged 21%,

24%, 22%, and 12% from 1997-2000, respectively. We feel that losses were lower in 2000 as a result of fruit being more difficult to remove by machine during drought stress.

Not all of the fruit could be removed from the plants with machine harvest from 1997-00. Fruit remaining after the last machine harvest was hand harvested and ranged from 8.7% to 30.8 % of total yield for un-trellised plots compared to 5.4% to 15.5% for trellised plots. This fruit was likely on fruiting wood that was parallel to the row and thus was not adequately shaken to loosen fruit during machine harvest. In-row spacing has had no effect on percent of total yield that could not be harvested by machine.

High-density plantings (45cm) have taken from 37% to 97% longer to prune than the industry standard 1.2m spacing depending on year (data not shown). Pruning weight per plant has been negatively correlated with in-row spacing (data not shown).

3.2 Trellising

Trellising has had no effect on time of pruning or pruning weights to date. In 1997, when the plants were four-years-old, trellising had no effect on machine harvest efficiency which averaged 21% of total yield lost on the ground. However, from 1998-00, as the plants became mature, trellising improved machine harvest efficiency. In 1998, drop was 20% of total yield in trellised and 24.3% in un-trellised -- an increased efficiency of 4.3% of total yield with trellising. Trellising improved machine harvest efficiency by 7.8% and 3.1% of total yield in 1999 and 2000, respectively (Figure 3). The lower machine harvest efficiency in 2000 may have been the result of not raising the trellis wires high enough after pruning in the winter of 1999/00.

3.3 Summary

High-density plantings look promising for increasing blueberry production, as plants established at a 45cm in-row spacing have double the cumulative yield (establishment through year 7) of those established at the traditional 1.2m in-row spacing. However, it is not known at this time whether the higher density plantings will continue to produce higher yields than those at a wider in-row spacing. Yield reduction from 1999 to 2000 was higher at 45cm than at 1.2m, although this may have been due to drought stress. The higher density plantings have been more expensive to prune due to increased labor costs. In-row spacing has had no effect on machine harvest efficiency. However, trellising of 'Bluecrop' is recommended to significantly reduce machine harvest losses.

We plan to continue this study to look at the long term and economic effects of higher density planting.

4. Acknowledgements:

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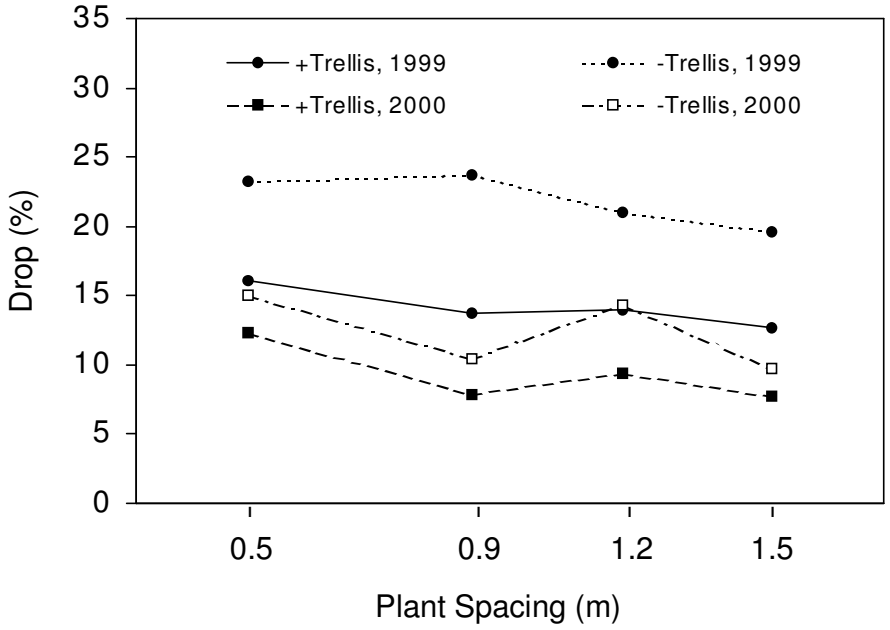

Figure 3. The effect of trellising on percent drop (of total yield) during machine harvest of 'Bluecrop' at different in-row spacings in 1999 and 2000.

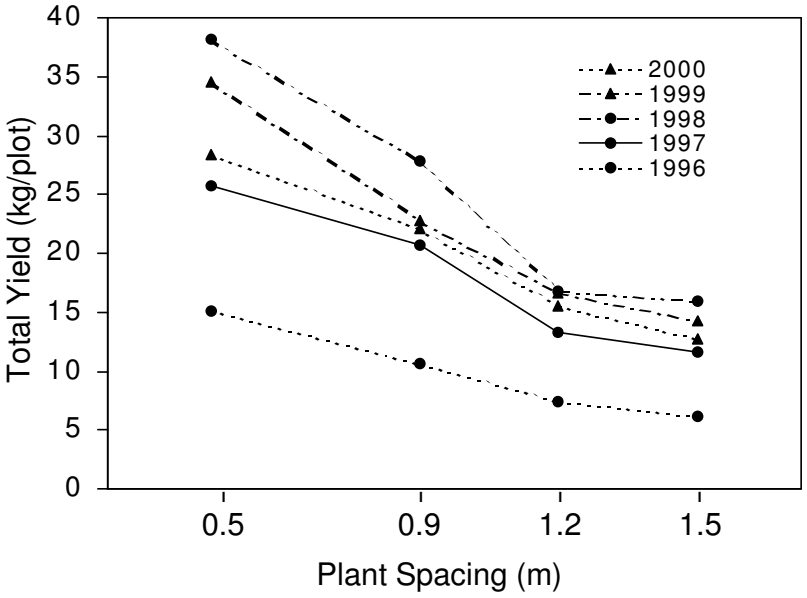

Figure 1. The effect of in-row spacing on total yield of 'Bluecrop' (established in Oct. 1993) in 1996-2000. Un-trellised treatments only.

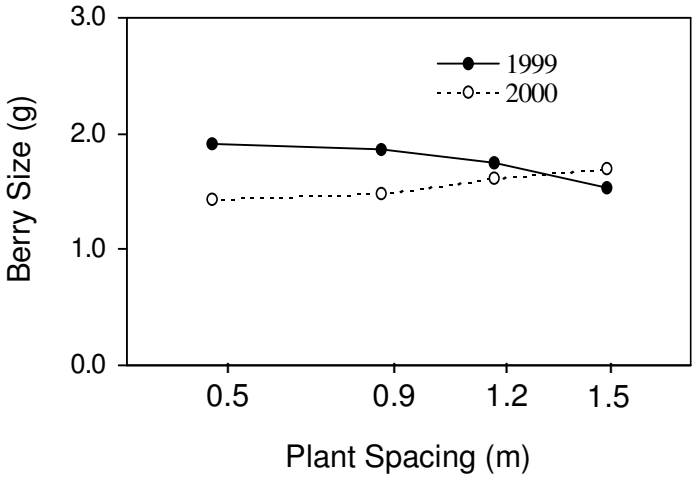

Figure 2. The effect of in-row spacing on berry weight of 'Bluecrop' in 1999 and 2000. averaged over trellis treatment.