Interim - Annual Report, Year 1 of a 2 Year Study (2008)

Title: Pruning Management for Primocane-fruiting Blackberry Production in High tunnels in Arkansas.

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Objective

The objective of this proposal is to develop pruning strategies to delay the flowering of primocane-fruiting blackberries to avoid high summer heat for extend high tunnels production in Arkansas.

Justification

Fall primocane blackberry production offers opportunities to improve farm income and to expand the market season through an extended production season. However, primocane blackberries in the south and southeastern regions are limited by hot temperatures during the flowering and fruit set period and early frost during fruit maturity. This may be overcome with techniques to delay flowering and fruiting until more favorable weather, and the use of high tunnels to protect during colder temperatures.

Primocane blackberry flowering can possibly be delayed with pruning treatments to avoid high summer heat (1, 2, 3) and then extend harvest with the use of high tunnels. Previous studies in Arkansas indicate that pruning methods may delay primocane flowering (3, 4, 5). In Oregon, successful pruning treatments were developed which delayed bloom and extended fall production (4). Based on preliminary tests, these treatments have not been adequate for delaying harvest in Arkansas. Most previous studies conducted at varied geographic locations have relied on pruning at various heights early in the season to delaying bloom. Such treatments alone have not been sufficient to delay bloom in preliminary trials in Arkansas. However, there are few previous studies of pruning primocane plants to the ground (e.g. "mowing") that have been demonstrated useful as a means of shifting bloom time. Additional research is needed based upon existing reports of delaying flowering in primocane raspberries (2) in order to develop a management system which would adequately delay bloom and fruiting in Arkansas and other sites in the southern region.

Work to Date

Introduction Two sets of studies have been conducted to accomplish the objectives of the project. The first studies were preliminary to establish a knowledge base for the second study which is the primary effort of this project. The studies were as follows. 1) A trial was established in 2006 to compare high tunnel versus field production with three primocane

genotypes for fall-only production, and 2) A trial specifically for this project was established during the 2008 growing season. Details of both are presented below.

Study 1. Management of three fall fruiting primocane fruiting blackberry genotypes in high-tunnel and field conditions.

Plant Establishment in Study 1 Primocane-fruiting blackberry genotypes Prime-Jim®, Prime-Jan®, and APF-46 were planted in 2006 in 4 m plots at a spacing of 0.25m between plants and 2m between rows with rows. The design was a randomized complete block, with high-tunnel (HT) or field (FD) conditions as main factors, split-plot for genotype and pruning methods as treatments. Plants were grown through the 2006 season and no pruning treatments were applied.

In 2007, floricanes were removed on 6-Apr, and pruning treatments were applied as described in experiment 1 below. In 2008, floricanes were removed on 22- Feb and treatments applied as described in experiment 2 below.

Experiment 1- 2007. In 2007, plots were subdivided into three 1m sections within primocanes receiving one of the following pruning treatments: 1) Mow canes at ground level on 26-Jul; 2) Tip canes at 1 m and resulting laterals to 50 cm; and 3) Tip canes at 50 cm and resulting laterals to 50 cm. Treatments 2 and 3 were applied as needed throughout the season. Treatment subplots were randomly applied within each genotype plot in a randomized fashion for each plot

Experiment 2- 2008. In 2008, plots were subdivided into two 2m sections and treatments were applied as follows: 1) primocanes were hedged to approximately 75 cm height and 2) primocanes were mown to ground level, with both treatments applied .

Fruit harvest was taken three times per week as needed from the first ripe fruit until there was no significant yield remaining. Average and total yield data were analyzed as a weight per plot with dates as repeated measures, using the GLM procedure in SAS. Dates of first, peak, and final harvest were recorded. Median harvest date was calculated. Mean dates were tested for significant effects using the MIXED procedure in SAS.

Study 2. Pruning Primocane Blackberries for delaying and synchronizing flowering and fruiting for high tunnel production.

Primocane blackberries plots were established at the Horticultural Research Farm in Fayetteville, AR. Primocane blackberry selection 'APF 45" was planted May 22, 2008, in 3m plots with in-row spacing of 0.25m and 2m between rows Plants were mulched with wood chips immediately following planting. Plants were allowed to fully establish throughout the summer and fall of 2008 in order to develop strong root systems and crowns. Pruning treatments will be initiated beginning in May, 2009.

Results

General Results. In 2007, freezes in early November ended FD production while production in high tunnels was extended until late November. In 2008, a severe freeze 24-October of -5C ended production in both FD and HT where temperatures were below freezing. The HT only provided 1-2C temperature protection and it appeared that supplemental heating was required for preventing freeze damage to crops for extended harvest if severe freezes are anticipated. At the time of the 2008 freeze, there was significant crop still on HT canes but was destroyed by the lethal temperatures. Data may have appeared differently had fruit been protected from the severe freeze.

Study 1 - 2007 First harvest was not affected by growing condition (HT vs FD) but was affected by pruning treatment and genotype (Table 1). Berries grown in high tunnels had similar first and peak harvest dates but continued harvest three weeks after frosts limited harvest in field plots.

Mowing canes to the ground resulted in significantly delayed cane re-emergence, significant delays in flower formation and flowering (observation, no data recorded), and resulted in no fruit harvest in fall 2007. At the time of the end of the study (approximately 20-Nov, 2007) due to extremely cold temperatures in the tunnels, the canes that had been mowed had flowered and were fruiting but were approximately 10-20 days from fruit maturity. Although some (minimal) fruit were harvested from only a few of the replicate plots, and not all replicate plots, no statistical analysis could be conducted for this treatment and therefore data for this treatment was considered to be "zero" and not included in the statistical analysis. Clearly, the mowing was too late in the season to allow for cane reemergence, flower formation and fruit maturity. Additionally, in field plots, after mowing, weeds were a significant factor,

especially in the raspberry plots where cane re-emergence was slow and minimal. Weeds quickly invaded the plots quickly after mowing and became a major factor in cane performance. Weeds were less of a difficulty in the tunnels because of lower light and stronger cane emergence. Likewise, weed infestation was not as much of a problem in plots where canes were tipped or hedged.

Tipping canes at 100cm and again at 50cm resulted in delayed first harvest bud an earlier peak (largest) harvest compared to tipping canes at 50+50cm (Table 1). However, across growing conditions and genotypes, it did not affect median harvest date. There was no difference in average harvest or total yield between the two pruning treatments, however, the plots that received the tipping treatment of 100cm followed by 50 cm had a 10% larger average and total harvest than the 50cm+50cm treatment.

Study 2 – 2008. Harvest in 2008 was about three weeks later than in 2007. Growing condition did not affect first harvest, but berries in tunnels had their largest harvest almost month after those grown in the field, and the median harvest date was approximately 2 weeks later (Table 1). Because of an early severe freeze (described above), all treatments had the same last harvest date. Total yield in all plots and treatments was less in 2008 than 2007 due to the freeze which damaged an estimated 5-15% of the crop on the plants still maturing.

Mowing canes delayed first harvest, and peak harvest approximately two weeks compared to hedging canes (Table 3). However, the date of the median harvest was earlier in mowed cane plots due to a more continuous and uniform harvest.

Although not significant, the high-tunnel plots (data pooled across all harvest dates) averaged 10% greater average harvest than field plots, and a 15% greater total seasonal yield (Table 4). Berry weight, averaged across all harvests, was similar for high tunnels although on individual harvest dates were often significantly larger than average berry size from field plots.

Mowing plots reduced average per harvest yield by approximately 27% and total yield and total yield by 49%. These means were not statistically different due to variation among plots, 3-way factorial experimental design and small replication size (n=3).

General Preliminary Conclusions

High tunnels tended to delay and extend harvest, result in generally larger average harvest and total harvest, and larger average berry size. However, as the tunnels only provided minimal

protection against a severe freeze, additional protection may be necessary for protection for the delayed harvest advantage of tunnels to be manifest.

Mowing canes to the ground significantly delays harvest but generally resulted in reduced yields in the two years of this study. Mowing in mid-summer (~26-July) resulted in poor cane re-emergence, and such a delay in flowering that fruit never matured in the 2007 season. Mowing earlier in the season in 2008 resulted in significant weed infestation preventing strong cane emergence in some plots. Although not compared, soft tipping at either 100 or 50 cm did result in as much of a harvest delay as a harder hedging treatment. It appears that either mowing to the ground earlier (with sufficient weed control) or combinations of hedging and tipping, or combinations of mowing, hedging and tipping, may provide an additive effect of delay and requires further study.

Future Work

Experiment 3 - 2009. In the spring and summer of 2009, the following pruning treatments to delay flowering will be imposed upon plots as follows:1) prune to ground on May 15, 2) prune to ground June 15 3) prune to ground July 15, 4) prune to ground May 15 plus hedge (at 75 cm when canes are approximately 1m tall; ~ 30 days later), 5) prune to ground June 15 + plus hedge, 6) prune to ground July 15 + soft tip (at 50cm ht). Plots will be arranged in a completely randomized design with seven replications.

Date of flowering will be recorded and data will be collected for time of harvests, yield, average berry weight, and temperature. Cane number, size, branch number, and cane weight after harvest will be recorded as indicators of crop vigor and related to yield and fruit size.

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Figure 1. Aerial photograph of the primocane blackberry pruning trial in Study 1. The large box indicates the entire study area. The incorporated smaller blocks are the study plot areas being either field production or within high tunnels.

Table 1. Harvest dates of primocane blackberry genotypes with three pruning treatments and grown either the field or in high-tunnels, Fayetteville, AR, in 2007.

TRT	Date			
	1st Harvest	Peak Harvest	Median Harvest	Last Harvest
Main Effects of Growing Conditions				
High-Tunnel	3-Aug	28-Aug	4-Sept	20-Nov a
Field	3-Aug	28-Aug	1-Sept	3-Nov b
Main Effects of Pruning Treatments				
Mow*	--	--	--	--
Tip 100+50	7-Aug a	21-Aug a	2-Sept	--
Tip 50+50	3-Aug b	28-Aug b	1-Sept	--
Main Effects of Genotype				
Prime Jan	10-Aug a	28-Aug a	1-Sept	--
Prime Jim	3-Aug b	21-Aug b	11-Sept	--
APF 46	2-Aug b	21-Aug b	4-Sept	--

Dates followed by different letters are significantly different. Means separation by t-test, 5% level, using Fisher's Protected LSD.

*Data for the "Mow" treatment could not be collected due to significant delays in flowering and fruiting which resulted in fruit being lost to a freeze.

Table 2. Yield and fruit size of primocane blackberry genotypes with three pruning treatments and grown either the field or in high-tunnels, Fayetteville, AR, in 2007.

TRT	Average Harvest (g)	Total Yield (kg)	Average Berry Size (g)
Main Effects of Growing Conditions			
High-Tunnel	60.7	2.2	4.5
Field	61.4	2.2	3.2
	ns	ns	ns
Main Effects of Pruning Treatments			
Mow	--	--	--
Tip 100+50*	64.0	2.3	3.5
Tip 50+50**	58.1	2.1	4.1
	ns	ns	ns
Main Effects of Genotype			
Prime Jan	75.6a	2.7a	4.2
Prime Jim	38.0b	1.4b	2.8
APF 46	69.5a	2.5a	4.5
			ns

Dates followed by different letters are significantly different. Means separation by t-test, 5% level

Table 3. Harvest dates of primocane blackberry genotypes with three pruning treatments and grown either the field or in high-tunnels, Fayetteville, AR, in 2008.

TRT	Date			
	1st Harvest	Peak Harvest	Median Harvest	Last Harvest
	Main Effects of Growing Conditions			
High-Tunnel	20-Aug	2-Oct a	26-Sep a	24-Oct
Field	20-Aug	3-Sep b	17-Sep b	24-Oct
	Main Effects of Pruning Treatments			
Mow	1-Sep a	27-Sep b	19-Sep b	--
Hedge	21-Aug b	11-Sep a	2-Oct a	--
	Main Effects of Genotype			
Prime Jan	20-Aug	10-Sep b	9-Sep b	--
Prime Jim	20-Aug	2-Oct a	7-Oct a	--
APF 46	20-Aug	14-Sep b	26-Sep ab	--
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Dates followed by different letters are significantly different. Means separation by t-test, 5% level

Table 4. Yield and fruit size of primocane blackberry genotypes with three pruning treatments and grown either the field or in high-tunnels, Fayetteville, AR, in 2008.

Treatment	Average Harvest (g)	Total Yield (kg/plot)	Marketable Yield (%)	Average Berry Wt (g)
	Main Effects of Growing Condition			
High-Tunnel	83.7	3.7	65.8	4.3
Field	77.1	3.3	64.8	4.1
	ns	ns	ns	ns
	Main Effect of Pruning Treatment			
Hedge	91.0	4.4	63.8	4.3
Mow	66.4	2.3	68.4	4.2
			ns	ns
	Main Effects of Genotype			
APF 46	84.4	3.8	74.3	3.9 b
Prime Jan	83.1	3.7	70.2	4.0 ab
Prime Jim	79.3	3.3	65.7	4.3 a
	ns	ns	ns	

Dates followed by different letters are significantly different. Means separation by t-test, 5% level