Effects of Primocane Suppression Programs on Weed Management and Productivity of Red Raspberry

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Introduction:

Herbicides have been widely used for years to suppress raspberry primocane growth in the spring. Primocane suppression or "cane burning" is primarily conducted to aid in the mechanical harvest of berries, but an enhanced level of weed control within the crop row is a side benefit to the herbicide application. Controlling primocane growth may also force raspberry plants into partitioning more photosynthates into berry production and less into vegetative growth. Many raspberry growers, however, suspect that herbicides currently being used for this purpose may be leading to a decline in raspberry plant vigor after several years of use. A three-year study was conducted to determine the effects of a residual herbicide (dichlobenil) and annual primocane suppression (carfentrazone, oxyfluorfen, or glufosinate) on productivity and longevity of red raspberry in western Washington State, USA.

Acknowledgements:
Thanks are gratefully given to Steve Klauer, Chuhe Chen, and Martin Nicholson of WSU Vancouver for their technical support during the three years of this study. Funds for this study were generously provided by the Washington State Red Raspberry Commission. Herbicides used were donated by the manufacturer.

Materials and Methods:

The experiment was established in three-year-old 'Meeker' raspberries at the Washington State University Vancouver Research and Extension Unit. Plots were centered on a single row of raspberry canes and measured approximately 10 m long by about 1 m wide (50 cm on either side of the row). Dormant-season dichlobenil was applied by hand February 23, 2000, January 9, 2001, and January 31, 2002 to both sides of the raspberry row. Cane burning products were applied to 15 cm-tall primocanes and weeds April 12, 2000, April 27, 2001, and April 22, 2002 using a CO_2-pressurized backpack sprayer. Herbicide rates are provided in the table. Two nontreated checks were included in the experiment.

Percent weed control, primocane suppression, and floricane injury was visually estimated to the nearest 5% at late flowering (June) of each year. Berries were machine harvested separately by plot during the harvest period for the block (at least 14 picks per year from late June through late July). Average berry weight (50-berry counts) were also recorded weekly during the harvest period. At mid-season of each harvest, eight floricanes were destructively harvested from each plot. From these canes, floricane height, berry number, lateral number, and lateral length were measured and dry weight partitioning between canes, laterals, leaves, and berries was determined. Average primocane growth was estimated by tagging 10 primocanes per treatment in May and measuring their height and basal diameter at least twice per month from May through August. Finally, floricane and primocane counts were made in late October of each year (prior to winter pruning). The experimental design was a randomized complete block with four replicates. Means were separated using Fisher's Protected LSD ($P<0.05$).

Results:

Decline in this raspberry planting, presumably to root rot, was apparent by the beginning of 2002, although the amount of injury attributable to the herbicide program was less obvious. Certain treatments in certain replicates showed significant decline, but raspberries treated with the same treatments in other reps remained healthy. For example, in two plots of carfentrazone used alone (replicates 1 and 3), raspberries showed marked stand injury, while carfentrazone plots in replicates 2 and 4 showed no significant decline. And since the dichlobenil + carfentrazone combination caused very slight or no raspberry injury in all four replicates, it appears that herbicide application was not primarily responsible for raspberry decline at this site.

Primocane burn was acceptable for all cane burning treatments, ranging from 90 to 98% (Figure 1). Dichlobenil alone or in combination gave excellent weed control (97 to 99%) after three years applications at 4.5 kg ai/ha (Figure 2). Cane burning products used alone resulted in lower weed control than when used sequentially with dichlobenil, and carfentrazone alone performed statistically poorer (58% control) than either oxyfluorfen or glufosinate used alone (79 and 75%, respectively).

'Meeker' berry yield was moderately affected by herbicide application (Figure 3). Most treatments did not yield significantly higher than untreated check plots. The poorest yielding treatments were dichlobenil + oxyfluorfen, carfentrazone alone, and the two untreated checks. Interestingly, the dichlobenil + carfentrazone treatment was numerically the highest yielder, indicating that carfentrazone used as a cane burning product is as safe as any of the tested herbicides. If those plots sustaining >50% decline were dropped from the analysis, there was no statistical difference between treatments, but all yielded numerically better than the untreated check plots, and dichlobenil + carfentrazone and glufosinate alone were statistically superior to untreated check #2.

Fruit size did not respond to herbicide application as neither cane burning nor dichlobenil treatment improved berry weight (data not shown). Fruit size was consistent in 2000 and 2001 (0.64 and 0.63 g/fruit, respectively) but size was reduced by some 15% in 2002 (0.54 g/fruit). This reduction is attributable primarily to weather conditions in 2002, given the lack of significance in the herbicide data or herbicide by year interaction.

It is difficult to say that the herbicide treatments were causing a reduction in raspberry plant vigor over time as evaluated in berry yield. If all plots are included in the analysis, there was no significant herbicide by year interaction. If those plots with >50% decline were dropped from the analysis, however, the interaction was strongly significant ($P > 0.0002$). The majority of that response was likely due to a substantial reduction in overall yield in 2002 (24.8 kg/plot in 2000, 33.4 kg/plot in 2001, and 17.3 kg/plot in 2002) that held true for all treatments (including the non-treated control plots).

Primocane and floricane counts differed between years, but only primocanes displayed a significant difference due to herbicide treatment (Figure 4). Untreated plots produced from 215 to 259 primocanes per plot in 2002, while dichlobenil + glufosinate and oxyfluorfen alone produced only 117 and 123, respectively. If those plots with > 50% decline were dropped from the analysis, non-treated plots in 2002 produced more primocanes than plants treated with dichlobenil + glufosinate or oxyfluorfen alone. All treated plots dropped an average 44 primocanes per plot by the end of the second season and only one additional primocane per plot by the end of the third season (45 primocane reduction from first season). The largest reductions in primocane counts were in the oxyfluorfen-treated plots, with or without dichlobenil (63 and 69 fewer canes, respectively) and dichlobenil + glufosinate (87 fewer canes).

Dry weight partitioning in individual floricanes did not change due to herbicide treatment (data not shown). Neither floricane nor fruit weight were significantly different between years, but branch and leaf weights generally increased from 2000 to 2001. When poor vigor plots were removed from the analysis, leaf weight was also significantly reduced in plots treated with dichlobenil alone or in the untreated checks. This may have resulted due to the larger number of primocanes being produced in these plots.

Primocane re-growth was slowest when oxyfluorfen was used either with or without dichlobenil, followed by carfentrazone and then by glufosinate (Figure 5). Raspberry primocanes treated with oxyfluorfen were thinner than primocanes from all other treatments until mid-July (data not shown) and shorter until mid-August. Dichlobenil did not restrict primocane growth when used alone, and re-growth from combination treatments was not slower than the re-growth after cane burning products were used alone.

Floricane height, berry number per floricane, and lateral number and length did not change much between 2000 (1st treatment year) and 2002 (3rd treatment year)(Table). When poor vigor plots were removed from the analysis, floricanes were shorter in 2002 compared to 2000 and 2001, more laterals were produced in 2001 compared to 2000 or 2002, while average lateral length and berry number were shortest/fewest in 2000 compared to 2001 and 2002. In addition, berry number per floricane was lowest in raspberries treated with dichlobenil alone, carfentrazone alone, or in the untreated checks. As with yield, however, raspberry floricanes treated with dichlobenil + carfentrazone produced the numerically highest berry count, indicating that carfentrazone was not causing this effect.

Figure 1a. 'Meeker' raspberries after three dormant-season dichlobenil treatments (note primocane height in foreground). 1b. 'Meeker' raspberries after three years of treatment with oxyfluorfen in spring. 1c. 'Meeker' raspberries after three years of treatment with dormant-season dichlobenil followed by carfentrazone in spring. All photos taken in June, 2002.

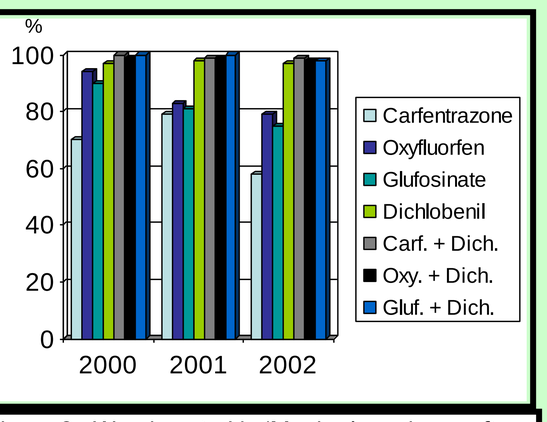

Figure 2. Weed control in 'Meeker' raspberry after three years of treatments with several herbicides.

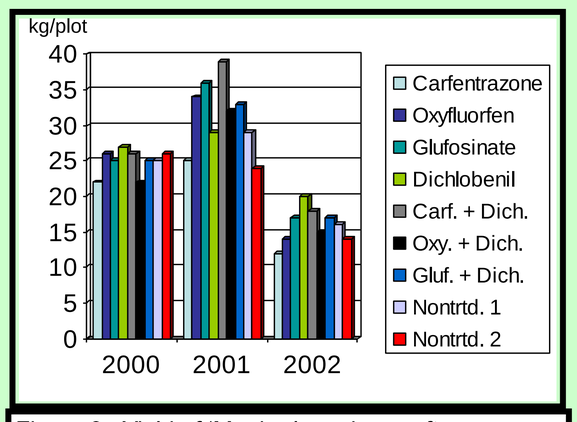

Figure 3. Yield of 'Meeker' raspberry after treatment with several herbicides.

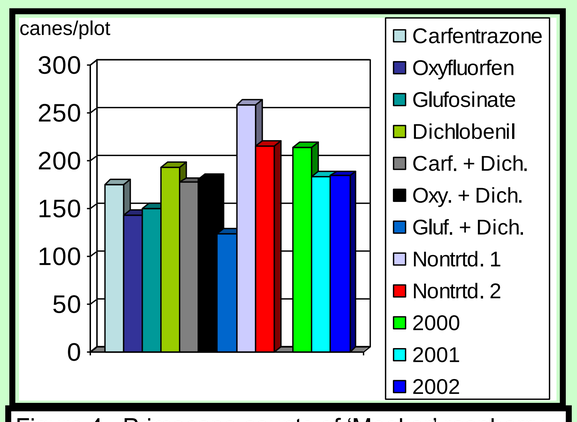

Figure 4. Primocane counts of 'Meeker' raspberry after three years of treatments with several herbicides (2002).

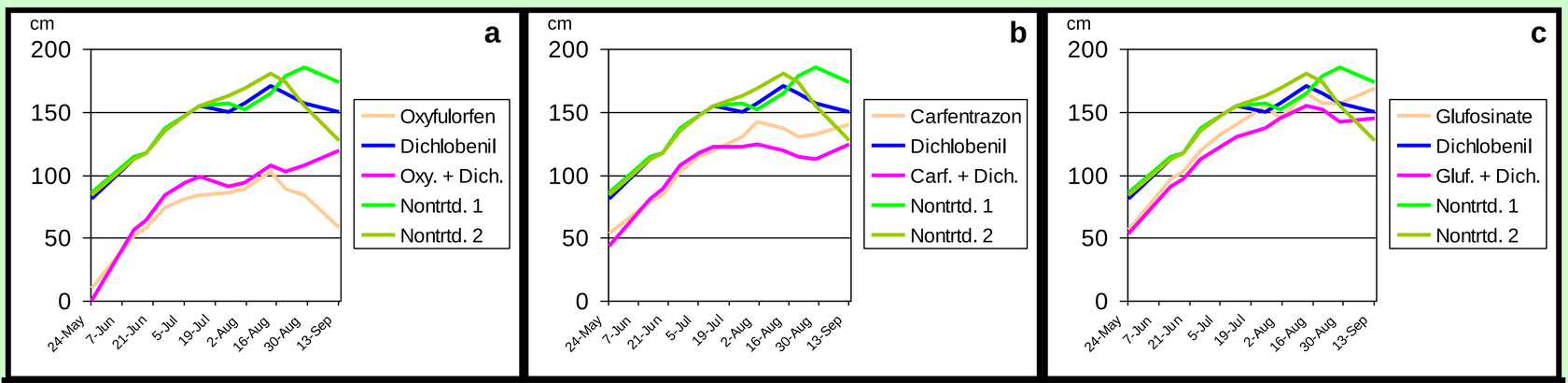

Figure 5. Primocane growth of 'Meeker' raspberry during 2001. a. Oxyfluorfen combinations compared to dichlobenil alone and nontreated checks. b. Carfentrazone combinations compared to dichlobenil alone and nontreated checks. c. Glufosinate combinations compared to dichlobenil alone and nontreated checks.

Conclusions:

It appears from these data that a cane burning program does not drastically alter 'Meeker' productivity. While the herbicide programs did not modify floricane height or lateral production, there was a trend toward more fruiting sites on treated raspberries compared to untreated checks. This trend did not result in greatly improved yield, although cane burned plots tended to have a higher three-year average than untreated plots. Berry size was not significantly impacted by herbicide treatment, but did vary by year. While weed control was notably improved by cane burning (some 60 to 80% compared to untreated checks), the residual program (dichlobenil) was in this case more important to ultimate annual weed control than was cane burning. All tested herbicides tended to reduce the number of primocanes produced, but cane burning did not as a rule reduce those numbers more than from a residual product alone. Of cane burning products, oxyfluorfen provided the longest suppression of primocane growth, followed by carfentrazone, and then by glufosinate.

Table. Floricane measurements after treatment with residual (dormant) and cane burning (spring) herbicides.

Residual		Cane burning		Floricane height			Berry number			Lateral number			Lateral length		
Product	Rate	Product	Rate	2000	2001	2002	2000	2001	2002	2000	2001	2002	2000	2001	2002
	kg ai/ha		kg ai/ha	cm	cm	cm	per cane	per cane	per cane	per cane	per cane	per cane	cm	cm	cm
Dichlobenil	4.5	None	0	252	260	250	129	155	163	17	19	16	38	38	41
Dichlobenil	4.5	Carfentrazone	0.1	240	280	241	126	204	192	16	22	18	37	42	39
Dichlobenil	4.5	Oxyfluorfen	0.5	243	242	169	160	165	129	17	20	12	38	36	30
Dichlobenil	4.5	Glufosinate	1.1	227	241	233	155	178	199	18	19	18	34	38	40
None	0	Carfentrazone	0.1	259	250	142	134	158	103	19	19	11	35	33	27
None	0	Oxyfluorfen	0.5	271	250	224	139	176	191	18	20	17	38	39	36
None	0	Glufosinate	1.1	249	266	220	132	186	199	15	19	19	39	40	36
None	0	None	0	232	271	250	119	154	140	17	19	16	35	39	36
None	0	None	0	251	247	229	145	126	144	17	18	16	37	37	37
Significance				---- P < 0.0001 ----			---------- P < 0.0208 ----------			---------- P < 0.0020 ----------			---- P < 0.1689 ----