Effect of perennial weeds on blackcurrant fruit yield and quality.

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Four species of perennial weeds at two different infestation densities were tested for their effect on berry yield and on resulting fruit quality in well-established blackcurrant during 2012. The trial was conducted at East Adamston farm (Andrew Husband, grower cooperator) near Muirhead (Angus), Scotland.

Materials and Methods

Six-year-old blackcurrant ('Ben Hope') was used for the trial. Existing monotypic weed populations within three adjacent blackcurrant rows were identified for this trial on 23 May; species were broadleaf dock (*Rumex obtusifolius*), couchgrass (*Elymus repens*), creeping thistle (*Cirsium arvense*), and willow-herb (*Chamerion angustifolium*). Infestations were rated as being "low" or "high" in density by species; plots were 1 m long, centered on a single row of blackcurrant bushes. Weeds were allowed to grow in the plots until most were in late bud stage, immediately before flowering of the first stems of creeping thistle and willow-herb, at which time weeds were clipped at the soil and above-ground fresh biomass was collected and weighed (26 July). Weed-free plots were kept free of all perennial weeds until harvest. All other weed species (both perennial and annual species) were removed by hand through berry harvest.

Plots were harvested by hand on 31 July, 2 August, and 6 August (replications 1, 2 and 3, respectively) and berries were weighed in the field. Additionally, 50-ml berry samples were collected from each plot and frozen at -80 C until used for fruit quality analyses. Three-berry subsamples were extracted for organic acid and sugar identification and quantification on 16-20 August and for vitamin C quantification on 27-28 September. Total fruit polyphenols were measured on 7 September and total anthocyanin on 18 September using a spectrophotometer. Sugars were identified and quantified on 29-30 August and organic acids were identified and quantified on 12-14 September, both using HPLC. Fruit remaining following extraction were processed for juice ºBrix score and pH on 26-27 September.

The experimental design was a randomized complete block with four replicates. Only replicates 1 through 3 were picked for yield, while all four replicates were sampled for fruit quality analysis. Data were analyzed using SAS, and means were separated using Fisher's Protected LSD ($P = 0.05$).

Results

Weed species alone did not affect berry yield or size (Table 1). Juice yield was better when produced with broadleaf dock than with other weed species, although these berries were also more acidic and had lower ºBrix. Total polyphenol content was greater when berries were produced with creeping thistle than with either couchgrass or willow-herb. Anthocyanin and sugar content was greater when berries were produced with quackgrass than with broadleaf dock or willow-herb. Vitamin C was content was better in fruit grown with couchgrass or willow-herb rather than broadleaf dock.

Surprisingly, weed density did not play a major role in these results (Table 2). Data were therefore combined across "low" and "high" density for these analyses. Several measured parameters were not closely related to weed density, but most parameters tended to be negatively

affected by weed competition. Although not statistically significant ($P < 0.05$), berry yield and fruit size was numerically reduced by presence of weeds, while polyphenol, anthocyanin, sugar, organic acid, and vitamin C content were also reduced. Conversely, berry number and juice yield were nonsignificantly increased by weed competition.

When analyzed taking into account weed species and contrasting with blackcurrants grown in the absence of these perennial weeds, several patterns emerged in the data (Table 3). Again, berry yield was not affected by the combination effect of weed species and density. Weed biomass was slightly biased toward willow-herb (2.02 kg/m^2) and away from couchgrass (1.03 kg/m^2), showing that that willow-herb was more productive in competition with blackcurrant than couchgrass. Broadleaf dock reduced ºBrix and pH of blackcurrant fruit, the only weed species to do so in this analysis. Vitamin C content of fruit competing with broadleaf dock was reduced in comparison to fruit from nonweedy blackcurrant, although creeping thistle and, to a lesser extent, couchgrass also reduced fruit content of vitamin C. Total polyphenol content was reduced by competition with willow-herb.

Preliminary Conclusions

Weed density was not a major factor in either yield or fruit quality, although the trend in the data was for negative consequences resulting from weed competition. Of the four perennial weed species tested, broadleaf dock caused the most negative effects in fruit quality, lowering juice ºBrix and pH, and lowering anthocyanin, sugar, and vitamin C content compared to other weed species. Willow-herb reduced polyphenol, anthocyanin, and sugar content, while couchgrass also reduced polyphenol and sugar content. Based on these single-year data, it appears that broadleaf dock should be the primary target for weed control efforts.

Table 1. Weed biomass, berry yield, and fruit quality parameters of 'Ben Hope' blackcurrant after season-long competition with four perennial weed species (2012).

Treatment[z]	Weed biomass	Berry yield	Berry number	Mean berry weight	°Brix	pH	Juice yield	Total polyphenols	Total anthocyanin	Total sugars	Total organic acids	Vitamin C
	kg/m^2	kg/m^2	no./sample	g/berry			L/tonne	mg/100ml	mg/500ml	g/L	g/500ml	mg/100ml
Broadleaf dock	0.82	2.08	21.8	1.00	14.2 b	2.56 b	534 a	3444 ab	2005 bc	340 b	57	0.58 b
Creeping thistle	1.00	2.07	20.2	1.05	15.1 a	2.62 a	486 b	3991 a	2491 ab	436 a	78	0.73 ab
Couchgrass	0.69	1.83	20.3	0.99	15.7 a	2.62 a	475 b	3355 b	2607 a	430 a	74	0.86 a
Willow-herb	1.35	2.14	20.0	0.99	15.3 a	2.60 ab	483 b	2868 b	1629 c	313 b	53	0.92 a
Pr > F	0.60	0.64	0.47	0.88	0.0008	0.03	0.003	0.01	0.003	0.002	0.14	0.02

Means within a column and followed by the same letter, or not followed by a letter, are not significantly different (P < 0.05).
[z]Weeds removed 26 July 2012; berries harvested 31 July-6 August 2012.

Table 2. Weed biomass, berry yield, and fruit quality parameters of 'Ben Hope' blackcurrant after season-long competition with or absence of weeds (2012).

Treatment[z]	Weed biomass	Berry yield	Berry number	Mean berry weight	°Brix	pH	Juice yield	Total polyphenols	Total anthocyanin	Total sugars	Total organic acids	Vitamin C
	kg/m^2	kg/m^2	No./sample	g/berry			L/tonne	mg/100ml	mg/500ml	g/L	g/500ml	mg/100ml
No weeds	0 b	2.17	20.1	1.04	15.1	2.60	485	3645	2273	399	67	0.80
Weedy	1.46 a	1.96	20.9	0.99	15.1	2.60	500	3277	2127	368	65	0.76
Pr > F	<0.0001	0.29	0.47	0.31	0.88	0.79	0.28	0.12	0.51	0.24	0.84	0.59

Means within a column and followed by the same letter, or not followed by a letter, are not significantly different (P < 0.05).
[z]Weeds removed 26 July 2012; berries harvested 31 July-6 August 2012.

Table 3. Weed biomass, berry yield, and fruit quality parameters of 'Ben Hope' blackcurrant after season-long competition with four perennial weed species (2012).

Treatment[z]	Weed biomass	Berry yield	Berry number	Mean berry weight	°Brix	pH	Juice yield	Total polyphenols	Total anthocyanin	Total sugars	Total organic acids	Vitamin C
	kg/m^2	kg/m^2	no./sample	g/berry			L/tonne	mg/100ml	mg/500ml	g/L	g/500ml	mg/100ml
Broadleaf dock	1.23 ab	2.10	21.5	0.99	14.2 c	2.55 b	529	3448 a	2149	346	58	0.56 c
Creeping thistle	1.57 ab	1.82	20.6	1.09	15.1 b	2.61 a	503	3827 a	2483	415	77	0.71 bc
Couchgrass	1.03 b	1.66	21.3	0.93	15.9 a	2.62 a	467	3214 ab	2326	419	74	0.80 abc
Willow-herb	2.02 a	2.27	20.1	0.99	15.2 ab	2.60 a	500	2686 b	1594	297	51	0.96 a
No weeds	0 c	2.17	20.1	1.04	15.1 b	2.60 a	485	3645 a	2273	399	67	0.80 ab
Pr > F	< 0.0001	0.23	0.87	0.22	0.002	0.02	0.12	0.02	0.23	0.08	0.08	0.04

Means within a column and followed by the same letter, or not followed by a letter, are not significantly different (P < 0.05).
[z]Weeds removed 26 July 2012; berries harvested 31 July-6 August 2012.

‘Ben Hope’ field.

Ripe ‘Ben Hope’ fruit.

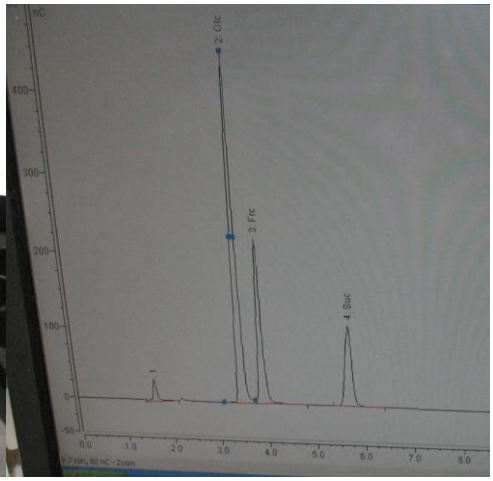
Couchgrass.

Creeping thistle

Willow-herb.

Hand harvest of fruit.

Fruit for weighing.



Fruit extract samples for HPLC analysis.

HPLC chromatogram for sugar content.