FINAL PROJECT REPORT

Project Title: Alternative nutrient, water and floor management strategies

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Total Project Funding

Budget History

Item	**Year 1:** 2005	**Year 2:** 2006	**Year 3:** 2007
Salaries	8,500	6,800	6,800
Benefits	4,165	3,332	3,332
Wages	2,800	2,240	2,240
Benefits	224	179	179
Equipment			
Supplies	2,661	2,129	2,129
Travel	450	320	320
Miscellaneous			
Total	18,800	15,000	15,000

Objectives
1) Study the impacts of drip irrigation on water use efficiency, fruit quality, storability, and yield of sweet cherry relative to micro sprinkler irrigation under different ground cover systems.
2) Compare ground cover [straw mulch or fabric (polypropylene) cover] vs. no ground cover, mulch cover vs. fabric cover, and white fabric cover vs. black fabric cover on water use, fruit quality, storability, and yield of sweet cherry, and on plant nutrition and soil fertility as well.
3) Evaluate the long-term impacts of black fabric ground cover on sweet cherry tree nutrition and soil nutrient supply.
4) Estimate the placement effects of organic fertilizers on sweet cherry tree nutrition and productivity.

Significant Findings
- Drip irrigation significantly increased the percentage of marketable fruit by reducing cherry surface pitting and bruising compared with micro sprinkler irrigation. Straw mulch, black fabric cover, and white fabric cover also increased the percentage of marketable fruit in some years.

- Drip irrigation saved over 70% of irrigation water each season compared with micro sprinkler irrigation averaged over the four ground cover systems.
- Fruit yield under drip irrigation was similar to that under micro sprinkler irrigation. However, there was a trend of yield increase, although statistically insignificant, with straw mulch and fabric covers.
- Fruit quality was generally comparable with drip irrigation relative to micro sprinkler irrigation, and with straw mulch and fabric covers compared with no ground cover.
- Soil available nitrate (NO_3^-) and potassium (K) contents were sometimes significantly lower with black fabric cover relative to no ground cover due to the greater removal of these nutrients by higher fruit yield in 2005-2007. Other nutrients did not differ between the black fabric cover and no cover treatments.
- Leaf nitrogen (N) concentration was enhanced by 9 to 19% with black fabric cover compared with no cover in 2005-2007. However, leaf phosphorus (P) concentration was lowered by 19% in the black fabric cover treatment in 2005; leaf Ca and S concentrations were significantly lower with black fabric cover in some seasons. Reduced leaf P, calcium (Ca), and sulfur (S) concentrations with black fabric cover were attributed to the tissue diluting effects due to greater tree growth and fruit production.
- The total uptake of N, P, K, Ca, magnesium (Mg), boron (B), manganese (Mn), and copper (Cu) nutrients by trees seemed to be significantly increased with black fabric cover relative to no cover. The enhanced uptake of nutrients from soil with the black fabric cover may be due to the larger soil volume penetrated by the root systems of ground-covered trees and increased soil temperature early in the spring.
- From a long-term perspective, more fertilizers need to be applied on black fabric ground-covered sweet cherry trees because of the increased tree growth and fruit production.
- Application of organic fertilizers directly on the top of black fabric cover was equally effective as the application of these fertilizers beneath the fabric cover; application of organic fertilizers directly on the top of black fabric cover could save labor.

Methods

Drip Irrigation and Straw Mulch Trial

A field experiment was initiated on Mel Omeg's orchard in The Dalles, OR in 2005, and was continued in 2006 and 2007. Two irrigation systems (single-line drip irrigation, micro sprinkler irrigation) and four ground management systems [mulch with straw, white fabric cover, black fabric cover, and control (no mulch or fabric cover, but herbicide was used to control weeds)] were evaluated in a split-plot design with four replications. Soil moisture measurements were taken weekly at a soil depth of 12 inches from May to September. Irrigation scheduling for each treatment was based on soil moisture content, and each plot was irrigated separately. Soil sampling was conducted at the depth interval of 0 to 12 inches for each plot each year about one month after fruit harvest. Soil nitrate, available P, K, Ca, Mg, S, B, Mn, and Cu contents were extracted using the Mehlich III method. Soil pH was determined with a 1:1 (soil:H_2O) solution, and organic matter was measured using the loss-on-ignition method. A leaf sample was taken randomly from each plot in August each year. The following nutrient concentrations were determined for these samples. Total N was determined using a combustion method. Total P, K, Ca, Mg, S, B, Mn, and Cu were digested in a CEM MDS 2100 series microwave using nitric acid and hydrogen peroxide, and the digest was analyzed on a Thermo Jarrel Ash 1100 ICP. Fruit yield, firmness, size, color, and sugar were determined for each plot. Visual evaluation of fruit surface pitting was conducted after the fruits had been stored in a cold storage room at 30^{o}C for three weeks. Four categories of excellent, slightly pitted, pitted, and bruised fruit were used in this evaluation.

IFP Cherry Trial

As part of an ongoing long-term research project on the use of black fabric cover, this study was conducted on a Van Horn fine sandy loam soil at the Mid-Columbia Agricultural Research and Extension Center in Hood River, OR from 2005 through 2007. The 1.2-ha orchard used in this study was planted at 18 ft. between rows and 10 ft. within rows in March 2001 with second-leaf Regina sweet cherry on Gisela 6 rootstock. The trees were trained to a central leader. This trial was initiated in 2001 in a randomized complete block design with eight replicates. Two ground management systems were evaluated. One treatment was 8-ft. wide synthetic black fabric, made of black woven polypropylene (DeWitt Co., Sikeston, MO), covering the tree row centers. This water-permeable polypropylene was placed on the ground in April 2001 with 1-ft wide edges buried in the soil on both sides of a tree row. The other treatment was the control (no ground cover, but with herbicide applications in the row area of same width to control weeds). Roundup (glyphosate) at 1388 ml ha^{-1} mixed with 147 liters ha^{-1} of water was sprayed in the control treatment in early June each year from 2005 to 2007. Fertilizer applications were based on shoot growth and nutrient concentrations in leaf and soil for this study. No N, P, or K fertilizer was applied to either treatment during the first three years (2001-2003) of the study. However, N fertilizer was applied to both treatments in April at 8 lb N $acre^{-1}$ in 2004 and 30 lb N $acre^{-1}$ in 2005 and 2006 as ammonium sulfate, and 80 lb N $acre^{-1}$ in 2007 as urea. Soil moisture content was measured weekly and irrigation was conducted during the irrigation season from May to September each year. Soil available nutrients were measured at a depth of 12 inches, and total nutrient concentrations in leaf were measured after harvest. Fruit yield, firmness, size, color, and sugar were determined for each plot. Visual evaluation of fruit surface pitting was conducted after the fruits had been stored in a cold storage room at 30^{o}C for three weeks.

Organic Fertilizer Placement Trial

A field experiment was conducted from 2005 through 2007 on a 1-acre black fabric-covered adult sweet cherry orchard that was transitioned into organic production in 2003 at MCAREC. Two types of organic fertilizers (fish meal and blood meal) and two placement methods of these fertilizers (broadcast application on the top of fabric cover, broadcast application to the beneath of fabric cover) were evaluated in a split-plot design with four replicates. Leaf chlorophyll concentration was measured during the season in 2005. Soil available nutrients were measured at a depth of 12 inches, and total nutrient concentrations in leaf were measured after harvest. Fruit yield, firmness, size, color, and sugar were determined for each plot.

Results and Discussion

Drip Irrigation and Straw Mulch Trial

In 2005, differences in soil available N, P, K, Ca, Mg, S, B, Mn, Cu, pH, and organic matter were primarily negligible between drip irrigation and micro sprinkler or among no cover, straw mulch, black fabric cover, and white fabric cover (data not presented). However, drip irrigation had slightly lower concentrations of N, P, K, Ca, B, and Mn in leaves than micro sprinkler irrigation after harvest (Table 1); which suggests that the uptake of these nutrients by roots may be slightly reduced due to the switch from micro sprinkler irrigation to drip irrigation in the first year. Unlike the irrigation systems, the four ground cover treatments had similar leaf nutrient concentrations except N (Table 1). Both black and white fabric covers had significantly higher leaf N concentration than the no cover control.

In 2006, drip irrigation plots had significantly higher N and Mn, but lower K concentrations in leaf than the micro sprinkler irrigation plots, about one month after harvest (Table 1). The concentrations of other nutrients were statistically similar between these two irrigation systems. The above results suggest that the uptake of these nutrients, except K, by roots is not reduced due to the switch from micro sprinkler irrigation to drip irrigation in the second year. The four ground cover systems had similar leaf nutrient concentrations except Cu (Table 1).

In 2007, drip irrigation had significantly lower N and Mn concentrations in leaf than the micro sprinkler irrigation in August, about one month after harvest (Table 1). The concentrations of other nutrients were statistically similar between these two irrigation systems. The four ground cover systems had similar leaf nutrient concentrations except P, Mg, and S (Table 1).

Table 1. Effects of irrigation and ground cover systems on leaf nutrient concentrations.

Year	Treatment	N	P	K	Ca	Mg	S	B	Mn	Cu
		%	%	%	%	%	%	ppm	ppm	ppm
2005	Micro sprinkler	2.58	0.26	2.64	1.20	0.31	0.14	81.1	55.2	4.6
	Drip irrigation	2.46	0.21	2.36	1.05	0.31	0.14	67.6	49.1	3.1
	Significance	*	*	*	*	ns	ns	*	*	ns
	No cover	2.40	0.25	2.60	1.14	0.32	0.14	74.8	49.0	4.0
	Straw mulch	2.38	0.22	2.38	1.19	0.32	0.14	69.7	51.7	3.6
	Black fabric	2.75	0.24	2.55	1.12	0.29	0.15	80.0	55.3	4.1
	White fabric	2.55	0.23	2.46	1.06	0.31	0.14	72.9	52.7	3.8
	Significance	*	ns	ns	ns	ns	ns	ns	ns	ns
2006	Micro sprinkler	2.36	0.32	2.64	1.70	0.34	0.18	75.7	52.3	5.0
	Drip irrigation	2.54	0.31	2.31	1.81	0.38	0.18	72.6	62.7	5.5
	Significance	*	ns	**	ns	ns	ns	ns	*	ns
	No cover	2.43	0.33	2.45	1.73	0.38	0.18	74.6	53.9	5.1
	Straw mulch	2.40	0.33	2.54	1.87	0.36	0.18	73.3	58.5	5.2
	Black fabric	2.46	0.29	2.48	1.76	0.35	0.18	75.5	60.4	4.7
	White fabric	2.52	0.33	2.44	1.66	0.36	0.18	73.2	57.2	5.9
	Significance	ns	ns	ns	ns	ns	ns	ns	ns	*
2007	Micro sprinkler	2.74	0.29	2.51	1.34	0.37	0.16	73.2	58.4	5.52
	Drip irrigation	2.43	0.26	2.64	1.18	0.35	0.15	73.0	48.5	4.73
	Significance	*	ns	ns	ns	ns	ns	ns	*	ns
	No cover	2.72	0.28	2.52	1.29	0.40	0.16	72.6	52.3	5.07
	Straw mulch	2.57	0.27	2.49	1.35	0.36	0.15	73.6	52.7	5.17
	Black fabric	2.57	0.26	2.61	1.21	0.31	0.15	73.6	55.9	4.91
	White fabric	2.48	0.31	2.66	1.19	0.36	0.15	73.0	52.8	5.33
	Significance	ns	*	ns	ns	*	*	ns	ns	ns

* indicates the treatment effect is statistically significant at 5% probability level. Non significant effect is denoted by ns.

One of the biggest benefits with drip irrigation was saving water. In 2005, drip irrigation reduced irrigation water use by 74% relative to micro sprinkler during the entire season from May to September (Table 2). Compared with no cover, black fabric reduced water use by 8%, and straw mulch and white fabric had a 1 to 3% reduction in water use. In 2006, drip irrigation saved as much as 79% of the irrigation water relative to micro sprinkler during the entire season. Relative to no cover, straw mulch reduced seasonal water consumption by less than 1% while black and white fabric had a 3 to 5% increase in water use. In 2007, drip irrigation saved 71% of irrigation water relative to micro sprinkler during the entire season. Compared with no cover, straw mulch and white fabric cover has almost the same seasonal water consumption, but black fabric had a 7.1% reduction in water use.

In 2005, fruit yield with drip irrigation was similar to that under micro sprinkler irrigation (Table 2). There was a strong trend of yield increase with straw mulch and fabric covers, particularly with white fabric relative to no cover, although these yield increments were statistically insignificant. Because both irrigation and ground cover treatments were implemented in early May this year, these yield differences may not be fully attributable to the treatment effects alone. Fruit quality including sugar content, firmness, and fruit size did not differ regardless of irrigation or ground cover systems. In 2006, Fruit yield did not differ between drip irrigation and micro sprinkler irrigation when averaged over the four ground cover treatments (Table 2). There was a trend of yield increase, although statistically insignificant, with straw mulch and fabric covers, relative to no cover. Fruit quality was generally similar for the irrigation and ground cover systems. In 2007, Fruit yield with drip irrigation was similar to that under micro sprinkler (Table 2) when averaged over the four ground cover systems. There seemed to be a trend of yield increase with straw mulch and fabric covers relative to no cover. Fruit quality including fruit size and sugar did not differ regardless of irrigation system; but fruit size was larger with drip irrigation than micro sprinkler in 2007. Compared with no cover, straw mulch, black fabric cover, and white fabric cover all had fruit with higher sugar content and greater firmness. Furthermore, white fabric cover seemed to have smaller fruit relative to other ground cover systems.

Table 2. Effects of irrigation system and ground cover systems on irrigation water consumption and fruit yield and quality.

Year	Treatment	Water consumption (gallon/tree)	Yield (lbs/tree)	Sugar (^{o}brix)	Firmness (g/mm^2)	Size (mm)
2005	Micro sprinkler	3427.5	49.9	17.3	290	31.1
	Drip irrigation	893.5	48.9	17.3	298	30.8
	Significance	*	ns	ns	ns	ns
	No cover	2226.3	43.9	17.0	305	31.1
	Straw mulch	2160.0	49.0	17.5	286	31.1
	Black fabric	2042.8	49.3	17.1	299	30.8
	White fabric	2213.0	55.3	17.5	287	30.8
	Significance	ns	ns	ns	ns	ns
2006	Micro sprinkler	4323.8	178.8	17.3	259.7	25.8
	Drip irrigation	928.0	174.0	18.5	268.9	25.5
	Significance	*	ns	*	ns	ns
	No cover	2575.3	170.7	17.9	264.7	25.4
	Straw mulch	2564.0	181.3	18.0	266.6	25.7
	Black fabric	2654.0	175.5	17.5	270.5	25.7
	White fabric	2710.3	178.0	17.9	255.8	26.0
	Significance	ns	ns	ns	ns	ns
2007	Micro sprinkler	5490.0	63.0	19.9	305.6	30.3
	Drip irrigation	1577.5	61.9	20.6	343.2	31.0
	Significance	*	ns	ns	*	ns
	No cover	3590.6	59.8	19.2	310.3	30.7
	Straw mulch	3576.2	64.4	21.7	320.4	31.0
	Black fabric	3335.8	62.4	21.3	340.0	30.8
	White fabric	3632.4	62.1	20.4	326.9	30.0
	Significance	ns	ns	*	*	*

* indicates the treatment effect is statistically significant at 5% probability level. Non significant effect is denoted by ns.

In 2005, it was interesting that drip irrigation increased marketable fruit (clear + slightly pitted) by approximately five percent (absolute value) via reducing cherry surface pitting compared with micro sprinkler (Table 3). No benefits were found with straw mulch or fabric covers in reducing fruit pitting relative to no cover. In 2006, Drip irrigation increased marketable fruit (excellent + slightly pitted) by over four percent (absolute value) via reducing cherry surface pitting compared with micro sprinkler (Table 3). There seemed to be a benefit with black fabric in reducing fruit pitting and bruising relative to no cover. In 2007, drip irrigation increased marketable fruit (excellent + slightly pitted) by over six percent (absolute value) via reducing cherry surface pitting and bruising compared with micro sprinkler (Table 3). There also seemed to be a benefit with straw mulch and white fabric in reducing fruit pitting and bruising relative to no cover.

Table 3. Effects of irrigation system and ground cover systems on fruit surface pitting.

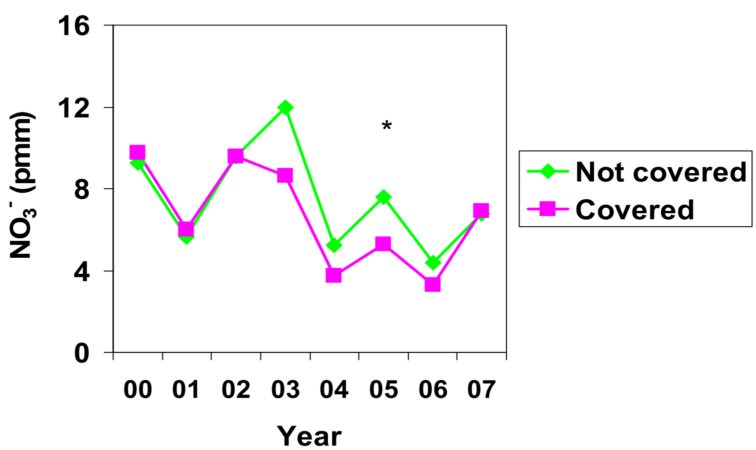
year	Treatment	Clear (%)	Slightly Pitted (%)	Clear + Slightly Pitted (%)	Pitted (%)	Bruised (%)
2005	Micro sprinkler	70.6	6.5	77.1	17.4	5.5
	Drip irrigation	76.2	6.2	82.4	12.6	5.0
	Significance	ns	ns	*	ns	ns
	No cover	75.8	5.0	80.8	14.4	4.8
	Straw mulch	71.5	6.8	78.3	15.8	5.9
	Black fabric	74.0	7.1	81.1	14.5	4.4
	White fabric	72.3	6.4	78.7	15.4	5.9
	Significance	ns	ns	ns	ns	ns
2006	Micro sprinkler	42.0	24.4	66.4	20.3	13.3
	Drip irrigation	44.2	26.6	70.8	19.2	10.0
	Significance	ns	ns	*	ns	ns
	No cover	41.8	24.7	66.4	23.0	10.6
	Straw mulch	41.8	26.7	68.6	18.7	12.7
	Black fabric	48.2	23.7	71.8	16.8	11.4
	White fabric	41.3	26.9	68.2	19.7	12.1
	Significance	ns	ns	ns	ns	ns
2007	Micro sprinkler	15.1	37.2	52.3	28.3	12.4
	Drip irrigation	22.1	36.6	58.6	25.3	9.1
	Significance	*	ns	*	ns	*
	No cover	14.5	38.3	52.8	30.1	10.4
	Straw mulch	24.4	36.3	60.6	21.8	8.7
	Black fabric	15.5	35.6	51.1	29.1	14.3
	White fabric	19.9	37.4	57.3	26	9.8
	Significance	ns	ns	*	ns	*

* indicates the treatment effect is statistically significant at 5% probability level. Non significant effect is denoted by ns.

IFP Cherry Trial

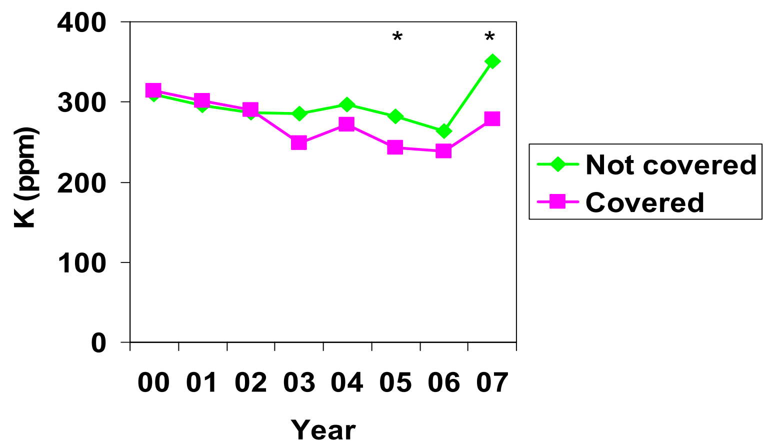
Soil NO_3^- content was statistically similar in the cover and no cover treatments in 2005, when soil under black fabric cover had a 30.3% reduction in NO_3^- compared with the non-covered soil (Fig. 1). However, Soil NO_3^- content was similar under the two treatments in 2006 and 2007. Difference in soil available P was not significant between the cover and no cover treatments regardless of year (data not presented). Soil under black fabric cover had similar soil available K content in 2006, but significantly lower soil K in 2005 and 2007 relative to the non-covered soil. The reduction in soil K was 13.6% and 20.6% in the covered soil over the non-covered soil in 2005 and 2007, respectively (Fig. 2). No significant effects of the black fabric cover on soil available Ca, Mg, S, B, Mn, and Cu, or pH were observed in any of the three years (2005-2007) (data not presented). Although black fabric cover serves as a physical barrier to prevent organic matter additions to the soil, no significant difference in soil organic matter was observed between the two treatments in 2005-2007 (data not presented). This trend may be attributed to the assumption that although tree leaves fall on the top of black fabric cover in the ground-covered treatment, they could still be decomposed by soil microbes and washed down through the black fabric cover and then down to the soil by rain and irrigation water.

Fig. 1. Black fabric ground cover effects on soil nitrate content.



* indicates the treatment effect is significant at P = 0.05.

Fig. 2. Black fabric ground cover effects on soil available potassium content.

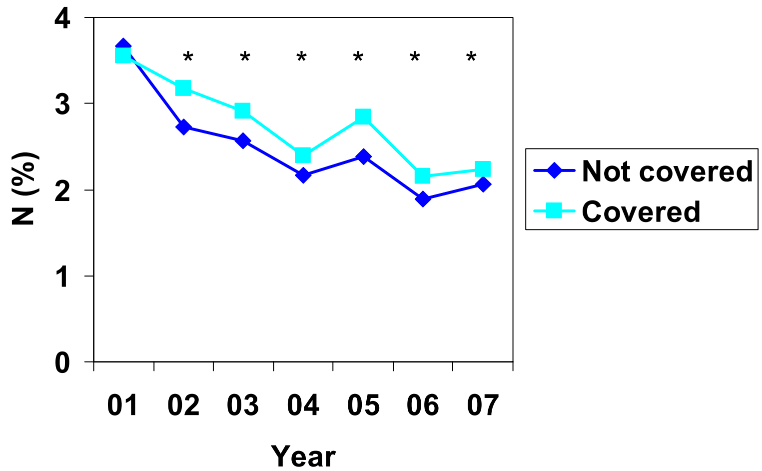


* indicates the treatment effect is significant at $P = 0.05$.

Overall, plots under different treatments had similar available nutrient levels in the soil during the first four years (2001-2004) of experimentation; after that, plots under black fabric cover had lower soil N and K levels in some years. This trend was within our expectation because tree growth and fruit yield were significantly enhanced by over 30% with black fabric cover compared with no cover during 2005-2007. Enhanced tree growth and fruit yield with black fabric cover increased the removal of nutrients from the soil, thus reducing available soil nutrient contents. Meanwhile, our results suggest that increased soil moisture content and soil temperature (data not presented) were both likely attributed to the greater tree growth and fruit yield with the covered trees.

Black fabric cover exerted a consistent effect on leaf N concentration during 2005-2007 (Fig. 3). Leaf N concentrations in August after fruit harvest were 19.3, 13.8, and 8.7 % greater with the covered trees than non-covered trees in 2005, 2006, and 2007, respectively. Because tree size and fruit yield was over 30% greater with cover than without cover treatments (data not presented), this suggests that the total amount of N uptake per tree has been substantially enhanced due to black fabric cover. Our results are different from those in western Canada (Neilsen et al., 2003) in that no significant differences in leaf N concentration were observed on apple trees between in-row black fabric cover and herbicide application in any of the six years from 1994 to 1999. Insignificant differences observed in the study of Nielsen et al. (2003) in western Canada were likely due to the fact that N was fertigated, which probably negated the fabric ground cover effect on leaf N relative to the control.

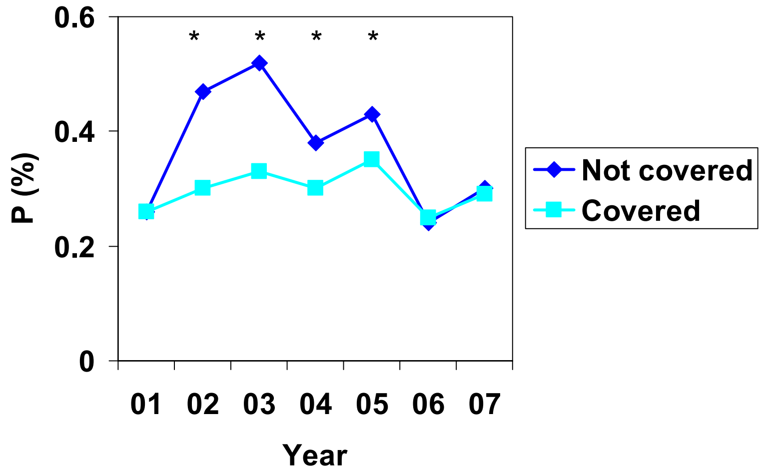
Fig. 3. Black fabric ground cover effects on leaf nitrogen concentration.



* indicates the treatment effect is significant at $P = 0.05$.

On the other hand, leaf P concentration in August after fruit harvest was 18.6% lower with the covered trees than the non-covered trees in 2005 (Fig. 4). However, leaf P level was almost the same for the two treatments in 2006 and 2007. Unlike N and P, leaf K concentrations were always the same for the two treatments during in 2005- 2007 (not presented). Our results generally contrast with those of Neilsen et al. (2003) on leaf P concentrations, but are consistent for leaf K concentrations.

Fig. 4. Black fabric ground cover effects on leaf phosphorus concentration.



* indicates the treatment effect is significant at *P* = 0.05.

Leaf Ca concentration in August was reduced by 9.2% in 2005 in the black fabric cover plots (data not presented). Leaf S concentration was lowered by 7.1, and 8.3% in 2006 and 2007, respectively, with black fabric cover (data not presented). The reduced leaf P, Ca, and S concentrations with the covered trees were attributed to the diluting effects of enhanced tree growth and fruit yield. Neilsen et al. (2003) also reported lower leaf Ca concentrations with black fabric ground-covered apple trees in two out of six years in their study. The effects of black ground cover on leaf Mg, B, and Mn concentrations in August, after fruit harvest, were statistically insignificant in 2005-2007 (data not presented).

Overall, our results suggest that leaf nutrient concentrations respond differentially to in-row black fabric ground cover, and the responses vary with the growing season. The total uptake of N, P, K, Ca, Mg, B, Mn, or Cu per tree per year seems to be significantly increased with black fabric cover relative to no cover because of an over 30% increase in both tree growth and fruit yield in the fabric covered treatment. The enhanced uptake of nutrients from soil with black fabric cover may be attributable to the larger soil volume penetrated by root systems of ground-covered trees, increased soil moisture supply, elevated soil temperature beneath the black fabric cover, and/or reduced competition from other plants such as weeds in the covered treatment. Our results indicate that the availability of all the nutrients in soil generally remains unchanged with black fabric ground cover. From a long-term perspective, more fertilizers need to be applied on black fabric covered sweet cherry trees because of the enhanced tree growth and fruit production.

Similar to leaf nutrient concentrations, the responses of nutrient concentrations in mature fruit to black fabric ground cover were nutrient-specific in 2005, the only year these analyses were made (data not presented). Fruit N concentration was 18.8% greater in the covered plots than non-covered plots. However, fruit P concentration was lowered by 8.3% because of polypropylene cover. Similar to N, fruit S concentration was increased by 33.3% with black fabric cover relative to no cover. No significant difference was observed in fruit K, Ca, Mg, B, Mn, or Cu concentration between the covered and non-covered trees.

Fruit quality, such as sugar content, firmness, and fruit size, generally did not differ between covered and non-covered trees (Table 4). However, fruit pitting evaluation showed that fabric cover increased the percentage of marketable fruit (clear + slightly pitted fruit) by reducing fruit bruising and pitting problems in some years (Table 4).

Table 4. Black fabric ground cover effects on fruit quality and surface pitting.

Year	Treatment	Sugar (^{o}brix)	Firmness (g/mm^2)	Size (mm)	Clear (%)	Slightly Pitted (%)	Clear + Slightly Pitted (%)	Pitted (%)	Bruised (%)
2005	Not covered	18.9a†	333,0a	28.5a	81.5a	4.8a	86.3a	8.4a	5.4a
	Covered	17.6a	335.0a	28.2a	87.5a	4.6a	92.1a	6.2a	1.7a
2006	Not covered	19.2a	245.5a	26.2a	32.4b	31.3a	63.8b	27.2a	9.0a
	Covered	19.6a	245.6a	25.9a	43.7a	29.7a	71.6a	18.5b	9.9a
2007	Not covered	23.8a	286.1a	27.7b	44.6a	26.8a	71.4a	23.8a	4.8b
	Covered	23.3a	288.6a	28.2a	45.9a	26.5a	72.4a	20.2a	7.4a

† Values in column followed by the same letter are not significantly different at 5% probability level.

Organic Fertilizer Placement Trial

Concentrations of soil available nutrients, such as NO_3^-, P, K, etc. after applying fish meal or blood meal on the top of the black fabric cover were similar to those following the application of the same amount of the same type of fertilizer directly to the soil surface by removing the fabric cover away from the tree row areas (data not presented). Leaf nutrient (N, P, K, etc.) concentrations did not differ between the two fertilizer placement methods either (data not presented). Since leaf chlorophyll is a good indicator of tree N nutrition status, we measured leaf chlorophyll content for each treatment from May to July in 2005. We found that leaf chlorophyll content was almost the same under the two placement methods for each of the two fertilizers during the growing season (data not presented), which suggests the placement method does not affect the availability of these applied organic fertilizers. Furthermore, fruit yield and quality (such as fruit firmness, size, color, and brix) were similar for the two placement methods in all three years (data not presented). Overall, our three-year results suggest that there is no need to apply fish meal or blood meal beneath the fabric cover. Application of these organic fertilizers directly on the top of the synthetic black fabric cover is equally effective and could save labor.