Bio-based Weed Control in Strawberries Using Sheep Wool Mulch, Canola Mulch, and Canola Green Manure

Bio-based weed control in strawberries

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Project Summary

Strawberry producers in Minnesota, and elsewhere, have lost or are soon to lose many of the chemical weed control options which they previously depended upon, i.e. Dacthal, methyl bromide, etc. Over reliance upon a small number of herbicides may be expected in the near future which could result in additional problems, both agricultural and legal, for producers. As a consequence of these actions and possibilities, producers of many horticultural crops are now desperate for management systems that include viable alternatives for weed control. Our proposed experiment with strawberries may serve as a model that has relevance to a number of other high value fruit and vegetable crops such as broccoli, cabbage, leeks, melons, tomatoes, and zucchini, to name a few.

Our objective is to reduce herbicide use in strawberry production through two mechanisms. The first involves research and demonstration of combined biological, cultural, and mechanical weed control, which is itself an example of integrated weed management. The second involves the substitution of a renewable resource-based fumigant/herbicide/mulch for weed management in strawberries, a crop directly consumed by the public.

Project Description

Lack of effective weed control is the major limiting factor in strawberry production. With few herbicides labeled for use in this perennial crop, weeds are controlled using manual labor, cultivation, and one or two herbicide applications (Pritts and Handley, 1998). However, these practices do not provide long term, effective weed control, and weeds continue to be the number one reason why strawberry fields are removed from production due to a reduction in yield (Propsom et al., 1999).

Strawberry growers in Minnesota currently apply herbicides up to three times in the establishment year – at planting, in mid- to late-June, and in late autumn before mulch is applied – and rototill and/or hand hoe twice or more as well. However, two problems have arisen from these methods. First, herbicides labeled for use on strawberries are decreasing in number, and we anticipate that the few left will become unavailable to strawberry growers within the next five years. Even if this is not the case, both herbicides and tillage can cause undesirable environmental effects. Consequently, their use should be discouraged when other options are available. Herbicides have been detected in surface and ground water at concentrations that exceed the maximum contaminant level for drinking water as established by the EPA (Goolsby et al., 1991). Mechanical tillage decreases the amount of plant residue on the soil surface, thereby increasing the risk of soil erosion (Laflen et al., 1980). Soil erosion causes on- and off-site environmental degradation and poses a threat to long term crop production (Larson et al., 1983).

Our project examines biologically based methods of weed management using strawberry as a model system. We evaluated weed control during strawberry establishment as affected by biologically and locally produced mulches – woven woolen mats (from locally reared sheep) and spring sown canola. The effects of these two types of mulches on weed control and strawberry production were studied independently and in tandem, integrating weed management for producers.

Research was conducted at two locations – the West Central Research and Outreach Center in Morris, MN and Pine Tree Apple Orchard in White Bear Lake, MN.

The following treatments, each replicated three times and arranged in a randomized complete block design, were established at both study locations:

Treatment	Treatment Description
1	Woven wool mulch, single-ply, centered on crop row
2	Woven wool mulch, double-ply, centered on crop row
3	Canola mulch created by gylphosate (Roundup) application in mid-May
4	Canola green manure created by disking to 100 mm (4") in mid-May
5	Canola "green" manure created by glyphosate application and disking
6	Wool mulch centered on rows and canola mulch between rows
7	Wool mulch centered on rows and canola mulch within and between rows
8	Standard herbicide treatments for Midwest strawberry production
9	Weed-free check (hand weeded)
10	Weedy check

The wool mulch material was a single-ply landscape fabric, 0.9 cm (3/8") thick and 61 cm (24") wide, and was fabricated from low-quality wool. Wool fabric was placed on the soil surface and held down with six inches long landscape stakes. Canola (Brassica napus cv) was the 'Dwarf Essex' variety. Strawberry plants were 'Glooscap' variety. Supplemental irrigation was supplied with a surface placed drip irrigation system. Each strawberry row had a drip line manufactured by Netafim (placed beneath the wool mulch where appropriate).

Site preparation was done with a field cultivator on April 19, 1999 at Morris and April 26, 1999 at White Bear Lake. Canola was seeded for appropriate treatments on April 20, 1999 at Morris and April 27, 1999 at White Bear Lake. Canola seed was seeded with a Gandy drop seeder at a rate of 10 lb/A (25 plants ft^2) and manually raked into the soil. Glyphosate was used to kill canola for appropriate treatments on June 8, 1999 at Morris and June 15, 1999 at White Bear Lake. All treatments, except treatment three, were disked on June 9, 1999 at Morris and June 16, 1999 at White Bear Lake and strawberry plugs were immediately transplanted on those days. Transplants were hand planted with 18" between plants in a row and four feet between the rows. There were three rows per plot. For wool mulch treatments, the transplants were inserted through three inch long slits cut through the fabric. In the standard herbicide treatment, immediately following transplanting, Dacthal WP was applied at a rate of 12 lb/A and incorporated with an overhead sprinkler. Strawberry transplants were visually inspected and dead plants were replaced one week after the transplanting date. For the standard herbicide treatment, a second application of Dacthal was made at a rate of 12 lb/A on August 4, 1999 and Devrinol was applied at a rate of eight lb/A on November 5, 1999. Strawberry plants were mulched with a five inch layer of wheat straw on November 10, 1999.

Results

Data Collection

Weed counts were determined in 6-25 x 40 cm (10" x 15") quadrants within each plot on July 13, 1999 and August 16, 1999 in Morris and on July 26, 1999 and August 25, 1999 at White Bear Lake. Three quadrants were centered on the strawberry row, and the remainder were centered between the rows. Within the quadrants, weeds were separated into two groups – grass and broadleaf weeds.

Strawberry plant growth was monitored by counting the number of rooted daughter plants in each of the aforementioned quadrants in each plot. Daughter plant counts were made on the same days as weed counts as well as on September 15 and October 13 for Morris and September 22 and October 20 at White Bear Lake.

At the Morris site, temperature at the soil surface and at a six inch depth was monitored for each treatment (one replication) using thermocouple temperature probes. Soil water potential was measured using Watermark sensors installed at a six inch depth below the row and between the row.

Data Analysis

Weed and daughter plant counts were compared by analysis of variance to test for differences between treatments. The Tukey's HSD method was used for means separation when treatment effects were significant at the 95% confidence level. Time-series analyses may be used for some data. For weed data, counts of grass and broadleaf weeds were grouped and the grouped data was compared.

Wool mulch, both single- and double-ply, was an effective barrier to weeds within the strawberry rows at both locations (Table 1). Adding the canola, both between rows and broadcast, to the wool mulch decreased the number of weeds in the entire plot. Canola without the wool mulch controlled weeds at a higher rate at the West Central Research and Outreach Center (WCROC) than at Pine Tree Apple Orchard in White Bear Lake. Disking canola, both as a green manure or sprayed with glyphosate, did not provide as good of weed control as when it was left on the soil surface. Canola that was sprayed with glyphosate and disked gave better weed control than the canola that was disked green. The

Table 1. Average number of broadleaf weeds and grasses per .3m² at the West Central Experiment Station in Morris, MN for August 16 and at Pine Tree Apple Orchard for August 25

	West Central Experiment Station		Pine Tree Apple Orchard	
Treatment	Broadleaf Weeds	Grasses	Broadleaf Weeds	Grasses
1	0a*	0a	1.00ab	0.11a
2	0a	0.11a	0a	0.67a
3	1.11a	0.22a	2.78ab	0.44a
4	4.78b	3.56b	6.45bc	1.78a
5	3.11ab	0.33a	3.11ab	1.56a
6	0.33a	0.89a	1.22ab	0.67a
7	0.11a	0a	0a	0a
8	0.11a	0.33a	3.11ab	0.44a
9	0.33a	0a	4.00ab	0.22a
10	5.11b	1.33ab	11.22c	1.78a

*Significant differences determined using Tukey's HSD at the 5% level.

Table 2. Average number of daughter plants per transplant at Pine Tree Apple Orchard and West Central Experiment Station for the months of August, September, and October

	West Central Experiment Station			Pine Tree Apple Orchard		
Treatment	August	September	October	August	September	October
1	1.17ab	0.67a*	0.67a	1.00a	9.89a	12.11a
2	1.56a	0.28ab	0.44a	0.67ab	11.22a	12.22a
3	0.50ab	0.39ab	0a	0.59b	2.89b	3.72bc
4	0.39ab	0b	0a	0b	1.17b	2.17bc
5	0.22b	0b	0a	0b	1.78b	2.22bc
6	0.83ab	0.22ab	0.28a	0.28ab	5.06b	7.06b
7	1.44a	0.17ab	0.56a	0.61ab	11.22a	14.00a
8	0.06b	0.17ab	0.06a	0.22ab	2.89b	4.94bc
9	1.44a	0.06b	0.56a	0.83ab	9.83a	14.22a
10	0.06b	0b	0a	0b	1.06b	1.67c

*Significant differences determined using Tukey's HSD at the 5% level.

canola that was sprayed with glyphosate and left as a mulch gave good weed control and seemed to have some residual activity in August.

The four treatments that included wool had the highest number of daughter plants when compared to all the other treatments except the weed-free plot (Table 2). Wool mulch with canola broadcasted had the most daughter plants out of all the treatments with wool. Wool mulch with canola between the rows had statistically fewer daughters than the other wool treatments. The canola treatments without wool mulch did not produce many daughter plants and were not statistically different from the weedy-check.

Soil Moisture and Temperature

Soil surface temperatures were affected by the wool mulch treatments, but not by any of the canola treatments when compared to the weed-free check plots. For the wool mulch treatments, maximum temperatures were consistently lower and minimum temperatures consistently higher than those without wool. Total temperature variation on a daily basis was least for the wool mulch treatments. At the six inch soil depth, soil temperatures were not different for the experimental treatments.

Differences in soil moisture (measured as water potential) were observed among the treatments, but the importance of these differences was minimal since all plots were irrigated to adequate moisture levels. The soil beneath the strawberry row generally dried faster (higher potential) for treatments with the most strawberry growth. The canola mulch treatment (treatment 3) and the wool mulch treatments were compared to the weedy check. Although it was expected that the mulched treatments would slow evaporation at the soil surface, the evapotranspiration was high for these treatments because of greater strawberry growth.

Management Tips

1. The use of canola, planted several weeks prior to strawberry transplanting, was shown to have varying degrees of weed suppression depending on how the canola was managed.

2. When canola was killed with glyphosate and strawberries transplanted through the canola-formed mulch, effective weed control was observed for more than eight weeks. Incorporating canola decreased the effectiveness. There was measurable weed control for these incorporated treatments, but not at a level acceptable for commercial production. Thus, the use of canola, when properly managed, as a biological control of weeds, is very promising for the strawberry establishment year.

3. Wool mulch was also very effective in controlling weeds.

4. Strawberry daughter plants rooted prolifically through the wool mulch and plants appeared vigorous and healthy when compared to the standard herbicide treatment.

5. The persistence of the wool and the economics of wool utilization will be critical in determining whether this approach will have any commercial application.

6. The impacts of both the canola treatment and the wool mulch on fruit production still needs to be assessed.

Cooperators

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Steve Poppe, West Central Research and Outreach Center, Morris, MN
Dr. Frank Forcella, USDA-ARS, Morris, MN
Dr. Neil Hansen, West Central Research and Outreach Center, Morris, MN
Dr. Bill Head, West Central Research and Outreach Center, Morris, MN
Bill Jacobson, Pine Tree Apple Orchard, White Bear Lake, MN

Project Location

The West Central Research and Outreach Center is located on Hwy 329 just east of Morris, MN. Pine Tree Apple Orchard is located on Pine Tree Road, off of Hwy 96 north of White Bear Lake, MN.

Other Resources/Citations

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