

**Ontario Ministry of Agriculture and Food  
Final Report - Project SR0005-W4S**

**PROJECT TITLE: EVALUATION OF COVER CROPS AND REDUCED TILLAGE SYSTEMS FOR WEED SUPPRESSION IN STRAWBERRIES**

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Background

Herbicide tolerance trials have been ongoing at several University of Guelph research stations for a number of years in order to provide new products for weed control in strawberries. While these trials have been successful, a more sustainable approach would be to develop an integrated weed management system for strawberries, which would include weed suppression techniques presently used in vegetable and field crop production, such as reduced tillage and cover crops.

Reduced tillage systems and the use of cover crops are methods which have been demonstrated to reduce weed pressure in other crops. No-till systems concentrate weed seeds in the upper 5-10 cm of the soil profile, allowing a more uniform emergence of weeds which can be controlled prior to transplanting. Stimulation of weed seedling growth is also reduced under low-tillage systems. Cover crops have been demonstrated to be useful in suppressing early season weeds in a number of horticultural crops, including strawberries. Rye is often found to be one of the better cover crops for weed suppression especially at high seeding rates. Work by Dr. Marvin Pritts at Cornell University noted that rye residue appeared to suppress weeds into the fruiting year, and suggested an allelopathic effect. Finally, reduced tillage systems also provide the benefits of maintaining soil structure, and reducing erosion potential in row crops.

The concept of Integrated Weed Management, as outlined by Dr. Clarence Swanton of the University of Guelph, suggests capitalizing on all possible weed control options to manage weed populations. This includes crop rotations, cover crops, planting patterns, intercropping, manipulation of fertility, tillage systems, chemical weed control, and a knowledge of critical periods of weed control in order to reduce the dependence on one single method. To date, little work has been done developing an integrated weed management program for strawberries.

Materials and Methods

A trial was established at the Cedar Spring Research Station (Fox gravelly loam - 47.8 % sand; 38.1 % silt; 14.1% clay) to evaluate the influence of reduced tillage and a rye cover crop on weed growth in strawberries, as well as document the development and yield of strawberries planted in reduced tillage systems. Rye was seeded on 26 September, 2000 at a rate of 150 kg seed/ha. The rye was allowed to grow to a height of 30 cm and on 30 April 2001, glyphosate was

applied at a rate of 2.5 l/ha to kill it. Tillage treatments were completed on 10 May and included the following 4 treatments:

- 1. conventional tillage:** rye residue was incorporated with a rototiller to a depth of 10-12 cm.
- 2. reduced tillage:** rye residue was partially incorporated with 2 passes with a conventional disk
- 3. zone tillage:** a single pass with a trans-till (single shank followed by double fluted coulters, providing a worked area 15-20 cm wide)
- 4. no-till:** no tillage operations

Superimposed on these main treatments were 3 weed control methods:

- 1. herbicide:** a single application of Sinbar was applied 5 weeks after planting, according to OMAFRA recommendations
- 2. weed free:** the plots were maintained completely weed free by hand hoeing
- 3. weedy:** no additional weed control was provided

Once the tillage treatments were completed, the amount of rye cover left on the surface was quantified in 2 ways; firstly by determining the dry weight of surface rye residue in a 0.5 m<sup>2</sup> area, and secondly by laying a 6.0 m rope with marks at every 15 cm diagonally across the plots and determining the percentage of times a piece of residue intersected with a mark on the rope.

Strawberry plants (cv. = Jewel) were supplied by a local propagator and certified under the Ontario Superior Plant Propagation Program. Oversized (>2.0 cm) and undersized (<1.0 cm) crowns were sorted out and removed. Plants were stored in their shipping containers at 0.5° C until they were planted.

To plant the no-till plots, a commercial Holland Model 1500 transplanter was retrofitted with a tool bar supplied by Holland Transplanter Co., which held 3 fluted coulters before the planting shoe, and was designed to plant in untilled soil. The only special modification made to the transplanter was to exchange the regular press wheels for custom manufactured narrow (4 cm) medal press wheels, which have been found to set plants better in no-till plantings. Tractor weights (80 kg) were also added to help get the shoe into the ground. The same planter was used to plant all tillage treatments. The strawberries were transplanted on 14 May, and trickle irrigation was installed within 2 weeks. Insects and diseases were managed according to Ontario Ministry of Agriculture recommendations, as outlined in Publication 360: Fruit Production Recommendations.

Once planted, the average distance between plants in the different tillage treatments was measured to see if there was slippage, since the press wheels are also the drive wheels for the transplanter. The target spacing was 25 cm. Plant performance in the various tillage and weed management treatments was determined by harvesting 5-6 plants 5, 10 and 15 weeks after planting, and determining leaf area and dry weights. At 10 and 15 weeks after planting, daughter plants were counted, separated from mother plants and leaf area's determined separately.

Weed suppression in the tillage/weed control treatments was determined by harvesting

and drying the weeds in 0.5 m<sup>2</sup> areas per plot. Weeds were also identified and counted per species, except for grasses which were grouped in one category.

In the spring of 2002, a 2.0 m section of row in each plot was marked off, and beginning on 24 June, plots were harvested twice weekly. Data was collected on total yields and average berry weight, and 5, 50, and 95% harvest dates were calculated.

The trial was established as a split plot with tillage treatments as main plots, and weed control treatments as sub-plots. The experimental design was a randomized complete block with 4 replications. No interactions were found between tillage treatments and weed control methods for any of the variables evaluated. Means in a column followed by the same letter are not significantly different based on Fishers protected LSD. A Type 1 error rate of 0.05 was used for all statistical tests.

## Results and Discussion

The rye cover crop established well, and winter survival was good. The rye was not fertilized in the spring, as it was assumed that there would be enough residual N in the soil; however, while the stand was good, the growth was not that vigorous, and the biomass produced was not as great as anticipated. Once the cultivation practices were complete, there were 4 times as much residue biomass on the surface and twice the density in the no-till plots relative to the conventionally cultivated plot (Table 1).

The modified Holland Transplanter transplanted strawberries into untilled rye cover crop with relative ease. Initially, it was difficult to get the planting shoe at the proper depth, but with the addition of extra weight, this was corrected. The only problems occurred in the zone-tilled treatments; we did our tillage treatments when the rye was still green, and the root ball was still intact, which made the tilled soil in the zone-till treatment less uniform than we would have liked. This allowed the mass of roots to plug between the coulters on a few occasions. Otherwise, with transplanter performance was excellent.

The number of plants which had to be adjusted by hand once they were planted did not seem to differ between the 4 tillage systems. However, the average plant spacing in the no-till plots was slightly less than the other the tillage treatments, suggesting that the narrow press wheels slipped slightly in tilled soil (Table 1).

Strawberry growth and development was not affected by tillage treatments (Table 2). Leaf surface area of mother plants was similar when evaluated 5, 10, and 15 weeks after transplanting, and leaf surface area of daughter plants and daughter plant numbers did not differ at 10 and 15 weeks. Plant dry weights (biomass) were also similar at 5, 10, and 15 weeks after planting.

Beginning at 10 weeks after planting, strawberry plant development was inhibited due to weed competition. Mother and daughter plant leaf surface areas, and daughter plant numbers were all significantly lower in the weedy plots relative to the weed free plots (Table 3).

Weed growth was significantly reduced in the no-till treatment up to 15 weeks after the tillage treatments were completed, as was indicated by a reduce overall weed biomass (Tables 4,6). Weed biomass in the zone-tilled treatments was higher than the no-till, even though the majority of the area was untilled, due to significant weed growth in the tilled zone. Although

weeds were suppressed by reduced tillage and cover crop systems, weeds were still present and this method alone was not considered adequate to manage weeds in strawberry plantings. The herbicide treatment (Sinbar) reduced weed development up to 10 weeks after tillage treatments were completed (Table 5)(which would be 5 weeks after Sinbar was applied), but 5 weeks later no difference was apparent (Table 7). Due to the dry conditions this summer, the activity of Sinbar was poor, and weed suppression was minimal.

Fruit yields were taken in the spring of 2002, and were found not to differ across tillage treatments (Table 8). Yields were significantly reduced in the weedy plots vs. the weed free plots (Table 9). Sinbar treated plots, in which the weeds were suppressed for the first part of the season tended to have lower yields relative to weed free plots, but differences were not significant. This supports earlier findings by Dr. Marvin Pritts at Cornell University, who reported that weed development early in the season has the greatest impact on yields. Overall, yield data was quite variable.

Berry weights were not affected by either tillage treatment or weed control method (Tables 8,9). Date of 5 %, 50 % and 95% harvest did not differ across tillage treatments (Table 8). The 5% harvest date of weed free plots was delayed relative to weedy and Sinbar treated plots.

### Summary

Establishing strawberries in untilled soil using commercially available equipment has no effect on plant growth and development when compared to more conventional tillage systems. Yields did not differ in this trial; however yield data was quite variable. No-till with rye cover crop significantly reduced weed development for the majority of the summer; however weed management by this technique alone is not acceptable. The addition of Sinbar only provided marginal weed suppression, due to inactivity because of the dry summer. Soil tillage treatments and weed management strategies acted independently of each other in terms of weed suppression and crop productivity.

**Table 1:** Summary of residue biomass, residue cover and final plant spacing in the various tillage treatments.

Tillage Treatment	Dry Weight (g/m <sup>2</sup> )	Residue Cover* (%)	Plant Spacing (cm)
Conventional	38.6 a	43.1 a	25.1 a
Disk	116.1 b	63.5 b	24.4 ab
Zone-till	107.0 b	78.8 c	25.5 a
No Till	167.7 c	86.2 c	23.8 b

\* - based on knotted rope technique

**Table 2.** Strawberry plant development in response to tillage treatments.

Tillage	Mother Plants			Daughter Plants				Biomass (g)		
	Leaf Surface Area (cm <sup>2</sup> )			Leaf Surface Area (cm <sup>2</sup> )						
	5 week	10 week	15 week	10 week	15 week	10 week	15 week	5 week	10 week	15 week
Conventional	275.4 a	798.9 a	1096.3 a	211.0 a	802.0 a	2.6 a	3.8 a	2.9 a	17.3 a	52.4 a
Disk	262.2 a	921.1 a	1047.9 a	193.9 a	781.6 a	2.9 a	3.3 a	2.8 a	18.4 a	34.9 a
Zone-till	265.2 a	954.7 a	1248.7 a	152.6 a	673.5 a	2.5 a	4.1 a	2.7 a	20.5 a	44.5 a
No-till	257.8 a	977.9 a	1001.4 a	162.3 a	692.9 a	3.5 a	3.1 a	2.5 a	21.1 a	45.1 a

**Table 3.** Strawberry plant development in response to weed control methods.

Weed Control	Mother Plants			Daughter Plants				Biomass (g)		
	Leaf Surface Area (cm <sup>2</sup> )			Leaf Surface Area (cm <sup>2</sup> )						
	5 week	10 week	15 week	10 week	15 week	10 week	15 week	5 week	10 week	15 week
Weed free	265.1 a	913.2 a	1098.6 a	180.0 a	737.5 a	2.9 a	3.6 a	2.7 a	19.4 a	44.3 a
Herbicide	295.1 a	775.9 ab	808.8 ab	147.9 a	355.7 b	2.2 ab	2.4 b	2.8 a	16.2 ab	24.3 b
Weedy	312.4 a	667.7 b	676.7 b	132.8 a	277.7 b	1.6 b	2.1 b	3.3 a	13.9 b	20.9 b

**Table 4.** Weed biomass and types in response to tillage treatments - 10 weeks after tillage treatment

Tillage	Biomass (g)	Weed types (plants per m <sup>2</sup> )						
		Ragweed	Lambs Quarters	Grasses	Clover	Dandelion	Purslane	Sandwort
Conventional	56.0 a	2.5 a	6.8 a	22.9 ab	10.8 a	5.0 a	4.5 a	0.8 a
Disk	42.8 ab	1.8 a	2.3 b	28.3 a	11.8 a	3.3 a	2.5 a	0.0 a
Zone-till	38.9 ab	2.5 a	2.5 b	15.1 c	17.4 a	4.5 a	3.0 a	3.3 a
No-till	30.8 b	1.0 a	0.3 b	19.5 bc	18.8 a	4.5 a	2.0 a	19.3 a

**Table 5.** Weed biomass and types in response to weed control methods - 10 weeks after tillage treatment

Weed Control	Biomass (g)	Weed types (plants per m <sup>2</sup> )						
		Ragweed	Lambs Quarters	Grasses	Clover	Dandelion	Purslane	Sandwort
Herbicide	35.1 a	2.0 a	3.3 a	19.7 a	7.0 a	3.4 a	1.1 a	7.1 a
Weedy	49.1 b	1.9 a	2.6 a	23.2 a	22.3 a	5.3 a	5.4 a	4.6 a

**Table 6.** Weed biomass and types in response to tillage treatments - 15 weeks after tillage treatment

Tillage	Biomass (g)	Weed types (plants per m <sup>2</sup> )						
		Ragweed	Lambs Quarters	Grasses	Clover	Dandelion	Purslane	Sandwort
Conventional	178.9 a	2.3 a	4.5 a	21.8 a	8.5 a	6.5 a	9.3 a	0.0 a
Disk	152.1 a	3.0 a	0.3 c	20.6 a	6.6 a	4.5 a	1.9 b	0.8 b
Zone-till	176.2 a	2.3 a	2.3 b	17.7 a	10.7 a	2.8 a	1.6 b	1.0 b
No-till	90.0 b	0.5 a	0.3 c	18.1 a	7.9 a	4.8 a	1.8 b	5.0 b

**Table 7.** Weed biomass and types in response to weed control methods - 15 weeks after tillage treatment

Weed Control	Biomass (g)	Weed types (plants per m <sup>2</sup> )						
		Ragweed	Lambs Quarters	Grasses	Clover	Dandelion	Purslane	Sandwort
Herbicide	154.7 a	2.3 a	1.3 a	21.2 a	3.6 a	4.0 a	2.4 a	2.0 a
Weedy	143.9 a	1.8 b	2.4 b	17.9 b	13.3 b	5.1 b	4.9 b	1.4 b

**Table 8.** Yield, average berry weight, and harvest duration in response to tillage treatments - spring 2002.

Tillage	Berry Weight (g)	Yield (t/ha)	Date of Harvest (1=01 June)		
			5 %	50 %	95 %
Conventional	12.3 a	14.9 a	24.2 a	29.6 a	33.5 a
Disk	11.5 a	11.3 a	24.3 a	28.7 a	32.4 a
Zone-till	11.8 a	11.0 a	23.4 a	28.0 a	33.3 a
No-till	12.1 a	13.7 a	23.8 a	29.2 a	33.5 a

**Table 9.** Yield, average berry weight, and harvest duration in response to weed control methods - spring 2002.

Weed Control	Berry Weight (g)	Yield (t/ha)	Date of Harvest (1 = 01 June)		
			5 %	50 %	95 %
Weed Free	11.9 a	12.8 a	23.9 a	28.9 a	33.2 a
Herbicide	11.9 a	10.3 a	21.6 b	27.6 a	33.2 a
Weedy	11.4 a	4.9 b	21.7 b	28.0 a	33.3 a