

# Green Manure Cover Crops Between Rows of Widely Spaced Vegetable Crops

Squash and pumpkin are grown with wide spaces between the rows. Tillage is commonly used to control the weeds between the rows but tillage is time consuming and damages the soil structure. Using herbicides to control weeds growing between the rows depends on identifying herbicides and application methods that are effective and crop safe. By planting low growing cover crops in the space between the rows it may be possible to suppress weeds while also contributing to the soil organic matter reserves.

This project evaluated the potential to grow green manure cover crops between the rows of a widely spaced, locally popular vegetable crop – pumpkins.

Spring planted winter wheat was used as the cover crop as it;

- a) is well adapted to Saskatchewan growing conditions
- b) produces a thick, short stature ground cover if planted in the spring. Spring planted winter wheat does not produce a seed head which prevents it from becoming a weed problem in subsequent crops.
- c) can be easily and safely controlled by a range of herbicides
- d) is readily available and inexpensive.

## Materials and Methods

The project was conducted at the University of Saskatchewan Horticulture Research Station (UofS) and at Roberston Valley Farms (RVF) in Saskatoon. Both sites feature clay soils which would benefit from improved soil health.

The pumpkins were transplanted into rows covered with plastic soil mulch. Four cultivars of Jack-O'-Lantern pumpkins were used at the UofS site and a smaller pie type pumpkin was grown at RVF. The rows were spaced 3 m apart at the UofS site and 2 m apart at RVF.

The between row treatments used at both sites were

**Green Manure Crop** - Winter wheat (cv. Accipeter) was seeded between the rows (June 5 at U of S, and on July 3 at RVF) using a small plot vegetable seeder. The wheat rows were 30 cm apart – with the outside rows planted as close as possible to the edge of the plastic mulch. Abundant rain resulted in excellent germination and growth of the winter wheat cover crop at both sites. The green manure crop was allowed to grow until it reached about 30 cm height – at which time a string type mower was used to trim the plants back to about 15cm (July 20 at the U of S site and Aug 9 at RVF). Mowing was designed to remove the seed heads from any weeds that had developed within the green manure planting. Mowing also checked the growth of the green manure crop.

**Tillage** – rotovators (hand or tractor mounted) were used whenever weed growth between the rows warranted the effort. The last tillage operation occurred just as the pumpkin crop was ready to vine out and fill the space between the rows. Hand weeding was used to catch the weeds that were too close to the plastic mulch to be removed by mechanical tillage.

**Herbicides** – the area between the pumpkin rows was treated with Chateau (flumioxazine by Valent mfg) at 200 g/ha + 1% glyphosate. A previous ADOPT project had shown that Chateau applied at this rate provided long lasting control of a wide spectrum of broadleaf weeds. The

glyphosate was added to kill any weeds that had already emerged prior to the herbicide treatment – as Chateau is only effective when applied prior weed emergence. The herbicides were applied using a shielded sprayer (Rogers mfg) which allowed for between row application of herbicides without spray drift onto nearby rows of sensitive crops. The herbicide treatment was timed so that many weeds had germinated before spraying but the crop had not yet reached beyond the edge of the mulch – as at that point the vines could potentially come into contact with the spray. **To insure that the area between the rows is effectively covered by this type of herbicide treatment, the between row spacing must closely correspond with the width of the shielded sprayer.**

The row middle management techniques (tillage, herbicide or green manure) were replicated twice at each site in a randomized complete block design. Each treatment was employed on the full length of a crop row (40 m at UofS and 80 m at RVF).

### **Data collected**

*Labor requirements* – the time it took to establish and maintain the various row middle management methods was recorded.

*Weed control and organic matter production by the green manure crops* – at two times in the growing season (U of S site - July 17 and Aug 15, RVF site – July 26 and Sept 16) all of the plant material was harvested in three 0.25m<sup>2</sup> sample areas selected at random within each between-row management treatment. The plant material was sorted as to whether it was the green manure crop (winter wheat) or weeds and then weighed.

*Yields* - the fruit were harvested at the first killing frost (Sept. 15). The number of fruit in the various between-row treatments was counted and their quality assessed.

### **Results**

#### **Weed Control**

At the UofS site, the tillage and herbicide treatments both provided effective control of weeds for the duration of the cropping season. At the first sampling date at the UofS site (July 17) about 1/3 of the total biomass in the green manure treatments was broadleaf weeds (Table 1), but by the second sampling date (Aug. 15) over 80% of the biomass in the green manure treatments was the winter wheat living mulch.

At the RVF site the chemical treatments again provided a high degree of weed control at both sampling dates (Table 1). However, the first tillage operation did not provide effective control of barnyard grass – likely as the field was very wet at the time of tillage. Barnyard grass also invaded the green manure treatment at the RVF site, representing about 50% of the total biomass in the green manure treatments at both sampling dates.

Organic matter production by the green manure treatments was estimated at about 2300 kg/ha (dry weight) at the UofS site and 1450 kg/ha at RVF. Less organic matter was produced at the RVF site due to the later seeding date for the green manure crop and

**Table 1. Influence of management practices on above ground fresh weight (kg/m<sup>2</sup>) of plant material growing between the rows of pumpkins at two sites**

Management	Plant type	U of S		Robertsons	
		July 17	Aug 15	July 26	Sept 16
Tilled	Broadleaf	0	0	0.03	0.10
	Grass	0	0	0.26	0.16
Herbicides	Broadleaf	0	0	0	0
	Grass	0	0	0.07	0.22
Green	Broadleaf	0.51	0.39	0.06	0.34
Manure	Grass	1.04	1.92	0.46	1.11

the narrower between row space at RVF. These estimates did not include any organic matter contributed by the pumpkin crop or the material added when the green manure crops were pruned back at mid-season. The organic matter produced by the green manure crops would represent a useful contribution to overall soil health. However, it does not nearly cover the estimated 60,000 #/a of organic matter lost/year in heavily tilled, irrigated and fertilized vegetable fields.

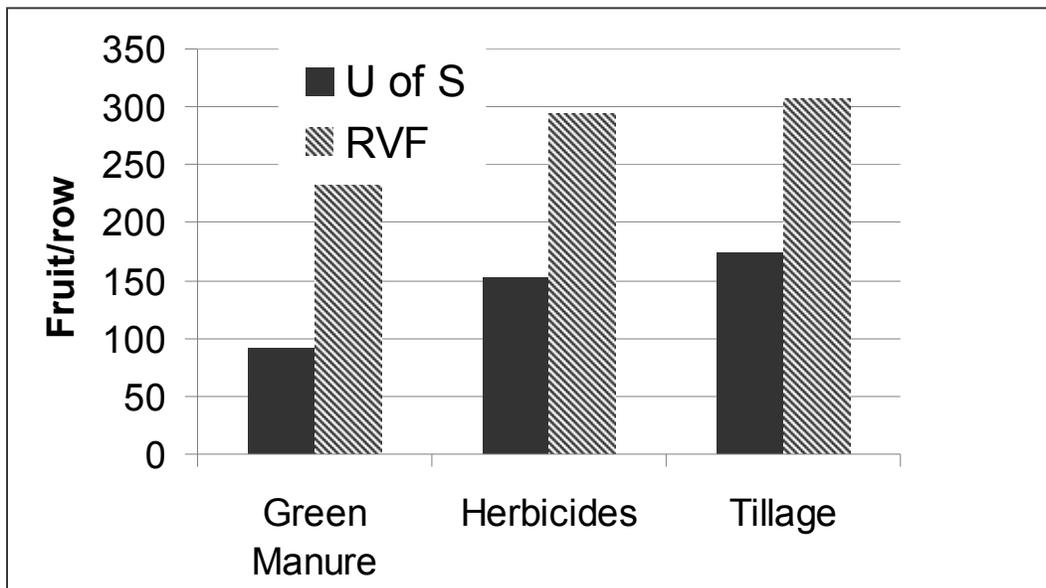
*Table 2. Labor Required for Management of Row Middle Treatments*

Green Manure	Herbicides	Tillage
<b>U of S Site</b>		
10 min. to seed	2 min. to spray	2 tillage operations @ 5 min = 10 min.
10 min. to top GM crop		
10 min. hand weeding	10 min. hand weeding	10 min. hand weeding
<b>Total – 30 min/row</b>	<b>Total – 12 min/row</b>	<b>Total – 20 min/row</b>
<b>Robertson Valley Farms</b>		
10 min to seed	2 spray operations @ 2 min. = 4 min.	2 tillage operations @10 min = 20 min.
10 min to top GM crop		
60 min. hand weeding	30 min. hand weeding	60 min. hand weeding
<b>Total - 80 min/row</b>	<b>Total - 34 min/row</b>	<b>80 min/row</b>

At both sites hand removal of weeds that escaped the various row-middle management techniques represented the single greatest labor cost (Table 2). Using herbicides to control weeds involved the lowest labor cost at both sites, while also providing the most effective weed control. Total labor costs in the green manure and tilled treatments were comparable. However, the level of weed control achieved in the green manure treatments was much poorer than in the other treatments – as it was impossible to completely hoe or pick out the weeds without also damaging the green manure crop. Treating the green manure crop with selective herbicides would address this problem.

Compared to labor, other costs such as fuel for rototilling, the seed for the green manure treatments and the chemicals used in the herbicide treatments would have been minimal. Chateau herbicide costs about \$ 22/ha while glyphosate is about \$8/ha.

*Crop Health and Fruit Yield* - by late July the vines had completely covered the 2m wide space between rows in the tilled and herbicide treatments at the UofS site. The smaller vines of the pie pumpkin variety planted at RVF were slower to develop into the 1m space between rows – but by the end of the season they too were well established in the area between rows managed by tillage or using herbicides. By contrast, at both sites, having a green manure crop established in the row middles suppressed the pumpkin crops' ability to vine out into this area. **The apparent restriction of vine growth by the green manure treatments appeared to reduce fruit yields (Fig. 8).** By preventing the vines from growing into the space between the rows the green manure crops may have reduced the overall photosynthetic capacity of the canopy – leading to the observed yield loss.



**Figure 1. Influence of row middle management technique on fruit yields of pumpkin grown at two sites in 2012.**

Fruit yields when the between-row areas were managed through tillage or herbicides were comparable at both sites (Fig. 1). Fruit number per row was higher at the RVF site than at the U of S site as the rows were longer at the RVF and the fruit of the pie pumpkin variety grown at RVF are much smaller than the Jack-O'-Lantern types tested at the UofS site.

The row-middle management techniques had no impact on fruit size, maturity at harvest or quality. There were few problems with fruit rot at either site – likely due to relatively dry conditions through the last few weeks of the 2012 growing season. In a wet fall having the pumpkins supported off the soil by a green manure crop may be reduce fruit rot.

## Conclusions

- a) spring planted winter wheat represented an excellent green manure crop to plant between rows in a widely spaced pumpkin crop. It quickly produced a thick canopy that choked out most weeds. It tolerated mowing which allowed additional control of weeds. As spring planted winter wheat does not set seed it will also not represent a potential weed in the next growing season. It also produced a large yield of organic matter which would benefit soil health.

- b) winter wheat as a between-row green manure crop appeared to interfere with the pumpkin crop vining out into the row middles – and this resulted in a yield loss. Even though the wheat had been trimmed back it appeared to represent a physical barrier that the pumpkin vines tended to avoid. This was surprising as pumpkin vines are large and fast growing, especially in the Jack-O'-Lantern cultivars tested at the U of S site.

This apparent physical barrier issue could be alleviated by;

- a. planting the winter wheat later, in more widely spaced rows, with greater space between plants within the row
- b. the winter wheat crop could be trimmed back more severely or killed out using herbicides or by crimping just as the pumpkin crop begins to vine out
- c. planting a less aggressive cover crop species

However, all of these solutions would reduce the ability of the winter wheat cover crop to suppress weeds and to contribute to soil organic matter reserves.

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