Agriculture, Pêcheries et Alimentation Québec

Final report of research completed as part of the Prime-Vert Program, sub-section 11.1 – Supporting the development of phytosanitary agricultural strategies in Québec

PROJECT TITLE:

Development of two methods to combat perennial sow thistle (*Sonchus arvensis L.*) and Canada thistle (*Cirsium arvense*) in organic field crop production.

PROJECT NUMBER:
CETA-1-LUT-11-1538

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MAIN FINDINGS (project summary)

Field experiments on two large-scale farms tested the use of two types of spring fallow to suppress sow thistle and Canada thistle. A spring fallow was followed by either harvestable buckwheat or a vigorous green manure crop. In 2011, spring fallow was followed with buckwheat. In 2012, both farms densely planted leguminous green manure crops (soybean or forage peas). The two experimental treatments were as follows: M0 – cultivate soils only in June; and M1 – cultivate soil in May and June. The buckwheat or green manure was sown directly after the June tillage event. The experiment consisted of four trials for sow thistle (2 farms * 2 years) and two trials for Canada thistle (1 farm * 2 years). The effect of M0 treatment was also observed in other fields besides the experimental field areas.

The experimental results indicate that following a short spring fallow with the planting of an aggressive green manure is effective for the suppression of Canada thistle or sow thistle. The number and timing of cultivation passes were important: to suppress sow thistle, two passes in June were sufficient, while an additional pass in May was necessary for Canada thistle. The results also indicate that it is very important to plant a competitive crop that is cultivated the following year.

Even though the perennial weed pressure was similar for both years for one of the farms and higher in 2012 than in 2011 for the other farm, the spring fallow was more effective in 2012 than in 2011, with a markedly greater reduction in thistle regrowth at the end of the season. Two factors may have been responsible: (1) the planting of more competitive crops following the experimental treatments; and (2) more effective tillage implements. In 2012, one tool, the Lemken Company's Kristall cultivator proved to be very effective relative to the others tested (heavy cultivators or a disc harrow). This tool has very aggressive chisel points that extract large numbers of rhizomes, which are left to dry out on the soil surface. This tool seems to have great potential in the effort to suppress any rhizome-type weed. The chisel points selected for this tool should be configured, however, to allow rhizomes to be lifted above the soil surface. The other cultivator used in 2012, designed specifically to enable shallow tillage while cutting rhizomes, also yielded good results.

Appendix 1: Detailed Methodology

Sow thistle was monitored on both farms while Canada thistle was studied on only one of the two farms. Therefore, there were four experimental years for sow thistle (2 farms * 2 years) and 2 experimental years for Canada thistle (1 farm * 2 years).

Cultural methods

The following tables present the cultural methods used on the two farms during the two-year study period.

Table 1. Cultural methods—Longprés Farm 2011

1st tillage	Tool:	Heavy cultivator with rod weeder
	Date:	May 23
	Depth:	5 cm
2nd tillage	Tool:	Heavy cultivator with rod weeder
	Date:	June 21
	Depth:	5 cm
Seeding of buckwheat	Seeding date:	June 21
	Seeding rate:	90 kg/ha
Incorporation of buckwheat	Tool:	Heavy cultivator
	Date:	September 15
	Depth:	5 cm
Fall tillage	Tool:	Goose-foot cultivator (scalper)
	Date:	October 26
	Depth:	5 cm

Table 2. Cultural methods—Longprés Farm 2012

1st tillage	Tool:	Goose-foot cultivator (scalper)
	Date:	May 18
	Depth:	12.5 cm (The soil was too wet to allow deeper tillage.)
2nd tillage	Tool:	Goose-foot cultivator (scalper)
	Date:	June 17
	Depth:	12.5 cm
3rd tillage	Tool:	Heavy cultivator
	Date:	June 22
	Depth:	5 cm
Cover crop seeding	Planting rate:	June 22
	Planting date:	Soybeans @ 200 kg/ha and Oats @ 20 kg/ka
Cover crop incorporation	Tool:	Lemken Ruben
	Date:	August 20
	Depth:	5 cm
Fall tillage	Tool	No fall tillage.

Table 3. Cultural practices—Mylamy Farm, 2011

1st tillage	Tool:	Amazon disc harrow
	Date:	May 20
	Depth:	5 cm and 10 cm (2 passes)
2nd tillage	Tool:	Amazon disc harrow
	Date:	June 24
	Depth:	7 cm
Seeding of buckwheat	Seeding date:	June 24
	Seeding rate:	33 kg/ha
Incorporation of buckwheat (fall tillage)	Tool:	Amazon disc harrow
	Date:	October
	Depth:	10 cm

Table 4. Cultural practices—Mylamy farms, 2012

1st tillage	Tool:	Lemken Kristall
	Date:	May 25
	Depth:	12-14 cm (2 passes)
2nd tillage	Tool:	Lemken Kristall
	Date:	June 14
	Depth:	20 cm
3rd tillage	Tool:	Lemken Kristall
	Date:	June 29
	Depth:	20 cm
Cover crop seeding (peas/oats)	Planting rate:	June 29
	Planting date:	4010 Peas @ 173 kg/ha and oats at 115 kg/ha
Cover crop incorporation	Tool:	None
	Date:	None
	Depth:	
Fall tillage	Tool:	No fall tillage

Treatments.

Two experimental treatments were used, as follows:

- M0—Soil cultivation only in June: in 2011, only one cultivation pass was made and in 2012, two passes were made, spaced by 1 or 2 weeks, depending on the farm;
- M1—Soil tillage in May in addition to the M0 June cultivation treatment.

Buckwheat or green manure cover crops were sown immediately after the final June tillage. In 2011, the two farms chose to plant buckwheat grown as a harvest crop. In 2012, the two farms densely sowed leguminous green manures (soybean or forage peas).

Experimental design

The experimental used a randomized block design with four replications. Each block corresponded to a field zone having a homogeneous and dense occurrence of Canada thistle or sow thistle. Blocks were divided in half and the two treatments were applied within each block.

Particularities related to the farms

Longprés Farm-

Additional information pertinent to the implementation of the experimental protocol

- The M0 treatment was applied to the entire 20-ha field. The M1 treatment was applied to one half of the divided experimental blocks (the other half-block automatically received the M0 treatment). It was thus possible to make general observations of the effects of the M0 treatment on Canada thistle and sow thistle for the whole field.
- In 2011 and 2012, the M0 treatment was also applied using the cultural methods described for 2012 to two 5-ha strips adjacent to the experimental field plot that were

intensely overgrown with Canada thistle and sow thistle. Visual observations of these bands were recorded 2012 at the same time of the collection of data from the experimental field areas.

Longprés Farm—2011: difficulties

In 2011, several problems were encountered during the set-up of treatments:

- Poor weather conditions forced the delay of the first cultivation and as a result, one of the following planned cultivations was omitted;
- Difficulties with the GPS equipment prevented Bio-action agronomists from being able to locate the border separating the treatments in each block for sow thistle counts. It was however possible to find the border separating the treatments for two of the four blocks used for Canada thistle counts.
- For the Canada thistle, a statistician confirmed that it would be possible to treat the two remaining blocks as four blocks because the May tillage pass was made through the middle of the plot, which means that each side of the plot received the M0 treatment. As a result, these blocks were subdivided and data were collected from from each sub-block, for two blocks in October 2011 and one of two blocks in 2012.

No difficulties were encountered in 2012.

Mylamy Farm—2011.

In 2011, the application of experimental treatments was not completely random (see the appended map). However, since the plots containing sow thistle were homogeneous, the results obtained are still useful. In order to be interesting, treatment effects must be clearly visible and for this experiment, this was easy to assess.

Measured parameters

The main parameters measured were the total number of Canada thistle and sow thistle plants and the percentage of ground covered by the thistles for three distinct dates: before the treatments, in the fall, as well as in the spring for the 2011 treatments (observations made in spring 2013 for the 2012 treatments are not included in this report).

Additional measurements were made during the study period:

- Thistle counts were recorded according to size, as follows: 0-4 leaves, 4-8 leaves and >8 leaves;
- In 2012, thistle counts were added in the summer (this data is presented in the Tables);
- At both farms (Longprés and Mylamy), thistles were counted during Fall 2012 in the test field used in 2011;
- At Longprés Farms, observations were recorded for the two additional fields receiving the M0 treatment that were not part of the formal study area;
- Photographs were taken each month as a visual record of observations made during the two growing seasons in the study period.

Appendix 2: Photos of machines and field areas

Photos of the machines used

Photos of the two soil cultivation tools used in 2012 are presented in Table 5.

Table 5. Cultivators used on the farms in 2012

Longprés Farm – Goose-foot cultivator made at the farm. The rhizomes are cut in heavy soils and are partially extracted in light soils.

Mylamy Farm – Lemken Kristall: large numbers of rhizomes are extracted.

Longprés Farm – Monitoring the 2011 experiment

May 25, 2011.
Left: M0 treatment/dense proliferation of Canada thistle. *Right:* M1 treatment.

June 10, 2011. Sow thistle predominates in rows previously planted to soy in 2010 and weakened due to in-row cultivation;
M0 treatment *(left)* and M1 treatment *(right).*

August 30, 2011: Sow thistle and Canada have overgrown the main buckwheat crop.

October 26, 2011. Sow thistle and Canada thistle plants are still visible.

Table 7. 2012 Photos of experimental plots– Longprés Farm

May 20, 2012 –M1 treatment (May 2011) effect is evident a year later (no thistle regrowth).

July 23, 2012.
Only Canada thistle is still visible; this trend persisted up until harvest.

October 18, 2012.
Sow thistle plants are not visible;
Canada thistle is present but is not dense.

Sow thistle growing in an area planted to storage-variety squash plants, which grew poorly. The soil was cultivated on August 30, 2012. Areas planted to squash with thistle regrowth (left) and soybean without thistle regrowth (right) are readily identifiable.

Longprés Farm – Application of M0 and M1 treatments in other field areas

Table 8. Photos of plots, before and after treatment in fields other than those used for the formal experiment—Longprés Farm.

June 2012. *Left:* Corn planted in May 2012 following a spring fallow/soybean green manure crop (similar to the M0 treatment as applied in 2012 in the main experiment). *Right:* Shows heavy pressure of Canada thistle and sow thistle; similar thistle pressure was present in spring 2011 in the area shown on the left side of the photo.

October 2012: A clean stand of corn. There are no visible sow thistle suckers. A small amount of Canada thistle is sparsely scattered within this area.

Longprés Farm- 2012 Experiment

Table 9. Photos representative of the Canada thistle pressure as a function of the treatments applied; sow thistle was nonexistent at this date (July 23) and did not regrow during the remainder of the growing season.

M0 Treatment

M1 Treatment

Mylamy Farm— 2012 Experiment

Table 10. Photos showing sow thistle before & after tillage—Mylamy Farm

Sow thistle just prior to application of the treatment in May (M1).

Sow thistle extracted by the Lemken Kristall cultivator.

Appendix 3. Field data results

In all cases, three counts were made per plot. Plot averages are presented below.

Longprés Farm

2011 Experiment

In order to perform statistical analysis, the two blocks for which it was possible to find the border between treatments (blocks 1 and 4) were subdivided as indicated in Figure 1.

Figure 1. Division of Block 1 into sub-blocks 1 and 11 (a similar procedure was used for block 4)

<table>
<tr><td colspan="4">Block 1 before the division (treatment M1 was done in the middle of the block)</td></tr>
<tr><td colspan="2">sub-block 1</td><td colspan="2">sub-block 11</td></tr>
<tr><td>M0</td><td>M1</td><td>M1</td><td>M0</td></tr>
<tr><td></td><td>May cultivation</td><td>May cultivation</td><td></td></tr>
<tr><td></td><td>  </td><td></td><td></td></tr>
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Table 11. Canada thistle counts: density (number of plants/m^2) and ground cover (%)- Longprés Farm, 2011

	Plants/m^2		% coverage	
	M0	M1	M0	M1
15-may-2011* Stage: 4-8 leaves and >8 leaves	**47**	**47**	**32**	**32**
1	17	17	6	6
4	77	77	58	58
24-Oct-2011 Stage: 4-8 leaves	**68**	**16**	**72**	**14**
1	47	17	72	17
4	95	21	80	17
11	41	12	70	16
41	90	14	67	7
14-May-2012 Stage: 0-4 leaves and 4-8 leaves	**28**	**12**	**11**	**5**
1	34	10	10	2
4	21	16	4	10
11	29	10	18	2
17-Oct-2012 Stage: >8 leaves	**8**	**1**	**3**	**0**
1	10	1	3	0
4	4	0	1	0
11	10	1	3	0

*Prior to carrying out treatments—only one count per block was made.

Table 12. Sow thistle counts: density (number of plants/m^2) and ground coverage (%) – Longprés Farm 2011

	Plants/m^2		% coverage	
	M0	M1	M0	M1
Sow thistle	**32**	**41**	**11**	**15**
15-May-2011* Stages: 0-4 leaves and 4-8 leaves	**103**	**103**	**35**	**35**
1	40	40	25	25
4	165	165	45	45
24-Oct-2011 Stage: 4-8 leaves	**21**	**33**	**10**	**21**
1	7	55	2	35
4	95	11	18	7
14-May-2012 Stage: 0-4 leaves	**1**	**29**	**0**	**6**
1	0	51	0	10
4	1	7	0	1
17-Oct-2012 Stage: >8 leaves	**2**	**0**	**0**	**0**
1	0	0	0	0
4	4	0	0	0

*Prior to carrying out treatments—only one count per block was made.

2012 Experiment

Table 13. Canada thistle counts: density (plants/m^2) and ground coverage (%) – Longprés Farm 2012

	Plants/m^2		% coverage	
	M0	M1	M0	M1
Canada thistle	**58**	**22**	**29**	**11**
14-May-2012 Stages: 4-8 leaves and > 8 leaves	**77**	**69**	**31**	**32**
1	79	64	43	38
2	71	62	30	25
3	75	69	25	33
4	82	81	27	30
23-July-2012 Stage: >8 leaves	**55**	**11**		
1	53	17		
2	51	5		
3	63	0		
4	51	23		
22-Aug-2012 Stage: >8 leaves	**33**	**2**	**45**	**0**
1	37	7	67	0
2	33	0	60	0
3	27	1	13	0
4	33	0	40	0
29-Oct-2012 Stage: 4-8 leaves	**69**	**6**	**11**	**1**
1	84	23	13	3
2	49	0	8	0
3	71	0	13	0
4	72	0	10	0

Table 14. Sow thistle counts: density (plants/m^2) and ground coverage (%) – Longprés Farm 2012

	Plants/m^2		% coverage	
	M0	M1	M0	M1
Sow thistle	**22**	**17**	**3**	**3**
14-May-2012 Stages: 0-4 leaves and 4-8 leaves	**77**	**69**	**8**	**10**
1	81	62	13	13
2	82	66	9	5
3	73	60	5	8
4	73	86	6	13
23-July-2012 Stage: 4-8 leaves	**6**	**0**		
1	3	0		
2	9	0		
3	4	0		
4	6	0		
22-Aug-2012 Stage: >8 leaves	**3**	**0**	**0**	**0**
1	0	0	0	0
2	4	0	0	0
3	3	0	0	0
4	5	0	0	0
29-Oct-2012	**1**	**0**	**0**	**0**
1	0	0	0	0
2	0	0	0	0
3	3	0	0	0
4	0	0	0	0

Mylamy Farm

2011 Experiment

Table 15. Sow thistle counts: density (plants/m^2)—Mylamy Farm

	Plants/m^2 M0	M1
20-May-2011 Stage: 0-4 leaves	**67**	**62**
1	82	59
2	73	71
3	55	28
4	57	90
26-Sept-2011 Stage: >8 leaves	**11**	**18**
1	27	8
2	15	25
3	0	1
4	0	40
14-May-2012 Stage: 0-4 leaves	**28**	**21**
1	41	3
2	37	36
3	14	4
4	21	39

2012 Experiment

Table 16. Sow thistle counts: density (plants/m^2) and ground coverage (%) – Mylamy Farm 2012

	Plants/m^2		% coverage	
	M0	M1	M0	M1
15-May-2012 Stage: 4-8 leaves	**76**	**75**	**69**	**64**
1	101	91	88	80
2	90	71	83	60
3	55	59	47	40
4	60	79	57	77
27-July-2012 Stages: 0-4 leaves and 4-8 leaves	**35**	**5**	**15**	**1**
1	38	2	17	0
2	58	6	28	1
3	20	7	4	1
4	22	5	10	0
07-Oct-2012 Stage: >8 leaves	**1**	**0**	**0**	**0**
1	0	0	0	0
2	2	0	0	0
3	1	0	0	0
4	1	0	0	0