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HULLESS PUMPKIN SEED: A NEW CROP FOR ORGANIC PRODUCTION IN QUÉBEC

PART 2 - Weeding Strategies

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The production of hulless-seed pumpkins for the snack market or for processing has the potential to spur crop diversification, especially on organic farms. However, pumpkins do not compete well with weeds at the start of the season and mechanical weeding is tricky. Pumpkin seedlings are fragile and the creeping habits of certain pumpkins make it difficult for machinery to pass close to the plants. For organic producers it is therefore important to develop efficient and economical weed control strategies.

A project was undertaken in 2011 and 2012 to evaluate four weed control protocols for use in organic production:

- Mechanical weeding as used by horticultural farms (WH)
- Mechanical weeding as used by field crop farms (WFC)
- Use of crimper-rolled rye mulch at 50% of anthesis in 2011 and at 100% in 2012 (CRM)
- Use of black biodegradable mulch (BBM)

These protocols were compared to a hand weedy check plot (WC) and a weed cover control plot (WC). We evaluated the impact of these weeding strategies on weed density and biomass, as well as on the yields of various hulless seed pumpkin cultivars: “Kakai”, “Snackjack”, and “Styriaca” in 2011, then “Snackface” and “Styriaca” in 2012. The time and the type of machinery required for the weeding operations were also evaluated.

Figure 1. Four weeding protocols were evaluated: field crop farm-type mechanical weeding (A), horticultural-type mechanical weeding (B), black biodegradable mulch (C) and crimper-rolled rye mulch (D).

Kaolin was sprayed on plants to protect them from the striped cucumber beetle, hence their white-coated appearance.

ONLINE VIDEO DEMONSTRATIONS

Flex-tine harrow

In-row finger weeder + inter-row S-tine cultivator with duckfoot shares

Inter-row S-tine cultivator with duckfoot shares

Table 1. Pumpkin planting protocols in 2011 and 2012*

	2011			2012	
	KAKAI	SNACK-JACK	STYRIACA	SNACK-FACE	STYRIACA
Transplanting dates:	June 8-9	June 8-9	June 8-9	June 8	June 8
Inter-row spacing (m)	3	3	3	2	3
In-row spacing (m)	0.5	0.3	0.5	0.3	0.3
Planting density (plants/ha)	6.667	11.111	6.667	16.667	11,111
Harvest dates	Oct 3	Sept 19	Oct 6	Sept 24	Oct 10

* Some features of these cultivars are presented in the report: ***Hulless pumpkin seed: a new crop for organic production in Québec. Part 1 – Cultivars and Planting Methods***

The trials were performed in sandy soil in two fields at the Organic Agriculture Innovation Platform (OAIP) research site in Saint-Bruno-de-Montarville. Plants were transplanted in early June after risk of freezing on the ground had passed. To protect the pumpkin plants from the striped cucumber beetle, they were sprayed with kaolin from the time of seedling emergence until the 5-leaf stage. The fruit was harvested at maturity, i.e., when the pumpkin foliage and stalks were dry and before the first fall frost.

For hand weeded plots, weeds were systematically removed to deliver the greatest possible crop yield. Conversely, the weedy check plot illustrated the weed cover potential of the experimental site.

For weeded plots, weeding tools were selected in accordance with methods usually used in horticulture or on field crop farms (Table 2). The number of operations and dates were chosen to achieve the greatest possible weed control and the least possible crop damage. Thus, mechanical weeding operations continued until the size and spread of the pumpkin plants made it impossible for equipment to pass through.

In 2011, hand weeding operations were carried out as needed on plots using horticultural farm weeding methods, as well as on plots covered with biodegradable black mulch. In 2012, weed pressure was too low to justify manual weeding as part of these treatments.

Given the abundance of weeds in the plots under rye mulch in 2011 and to be able to separate out the rye mulch and weed effects, we added two hand weeding operations to this treatment in 2012.

Table 2. Weeding operations in 2011 and 2012

	DATES OF THE WEEDING OPERATIONS				
	2011			2012	
WEEDING PROTOCOLS	JUNE	JULY	AUGUST	JUNE	JULY
Mechanical weeding, horticultural type					
In-row finger weeder + inter-row S-tine cultivator with duckfoot shares	21, 28			15, 22	
Inter-row S-tine cultivator with duckfoot shares		7			
S-tine cultivator with inverted duckfoot shares [a]				29	5
Hand weeding as needed		21			
Mechanical weeding, field crop farm type					
Flex-tine harrow	21			15	
S-tine cultivator with inverted duckfoot shares				22	
Inter-row S-tine cultivator with duckfoot shares	22, 28	7		29	5
Crimper-rolled rye mulch					
Hand weeding as needed [b]					5, 26
Biodegradable black mulch					
Hand weeding around plants and between raised beds		6, 18	9		
S-tine cultivator with duckfoot shares between raised beds	22, 28	7		22, 29	
Hand weeded control					
Only hand weeding	21, 28	7, 18	12	15, 22, 29	5

[a] Inverting the duckfoot shares position allows to throw the soil onto the rows and bury the weeds

[b] The rye mulch was not weeded in 2011

WEED COVER POTENTIAL AT THE SITE

At the end of the 2011 season, more than two-thirds of the weed species identified in the weed cover control plots were annual dicotyledons. The main species found were redroot pigweed (57% of total weed biomass) and lamb's-quarters (12%). Among the monocotyledons, smooth and large crabgrass were predominant—8% and 18% of total weed weight respectively.

In 2012 only six species of annual weeds were identified in the weeded plots, mainly lamb's-quarters (50%) and smooth crabgrass (40%).

WEED CONTROL

In 2011 and 2012, all weeding protocols, except rye mulch, led to significant reductions in weed biomass compared to the weed cover treatment (Figure 2). Biodegradable black mulch, with three hand weedings in 2011, resulted in no weeds at the end of the season. The mechanical weeding strategies (horticultural and field crop) provided good weed control. However, in 2011 mechanical weeding was less efficient for the Kakai cultivar and the weed biomass was higher within the rows, as compared to between rows.

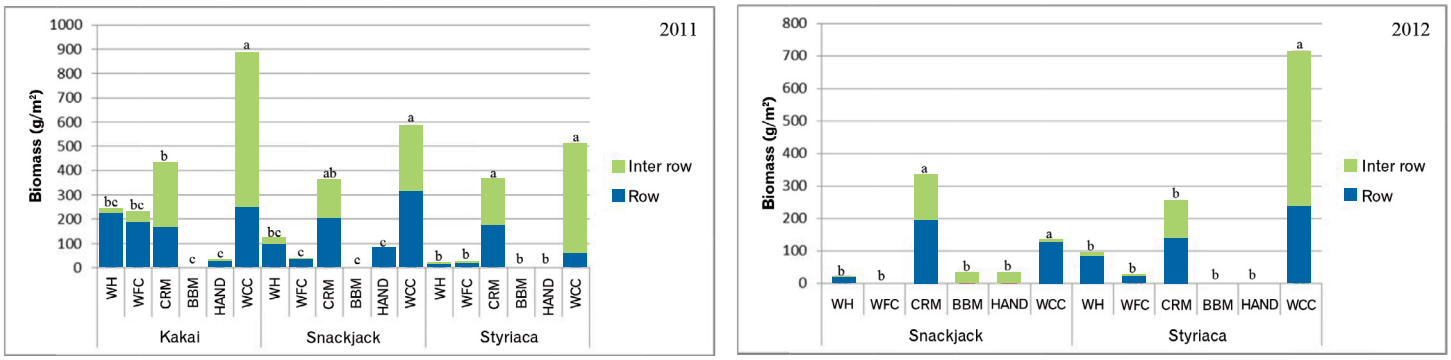

Figure 2. Impact of weeding strategies on weed biomass within and between rows at the end of the season, in 2011 and 2012.
For each cultivar, treatments with the same letter are not significantly different ($p \leq 0.05$).

WEEDING TIME

In 2011 the hand weeding protocol required the greatest number of work hours per hectare, followed by biodegradable black mulch—requiring three hand weedings. The number of hand weedings greatly affected the total duration of weed control operations. This is particularly noticeable when one compares mechanical weeding protocols; adding a single hand weeding to horticultural-type plots increased weeding times by 6 to 8 fold compared to the weeding times needed for field crop-type plots.

In 2012 hand weeding operations were added to the rye mulch strategy. So the work time allocated to this treatment became similar to that of the hand weeding treatment. The time required to weed biodegradable black mulch plots in 2012 was very similar to the time needed for the mechanical weeding protocols (horticultural and field crop), since no hand weeding was performed.

IMPACT ON YIELDS

Regarding cultivars, the marketable fruit yield for "Styriaca", as well as the average weight per pumpkin for "Styriaca" and "Kakai", were greater than that of "Snackjack" and "Snackface". However, the "Snackjack" and "Snackface" cultivars produced the best seed yields in 2011 and 2012 (Figure 3). These cultivars, planted more densely, produce smaller but more numerous pumpkins and with more seeds per fruit. They are also less sensitive to bacterial wilt, a disease that killed 34%, 6%, and 0% of the "Kakai", "Styriaca", and "Snackjack" cultivars, respectively, in 2011 and 1% of the "Styriaca" and "Snackface" in 2012.

Table 3. Duration of different mechanical and hand weeding operations in hulless-seed pumpkin crops, in 2011 and 2012.

	2011 (h/ha)			2012 (h/ha)	
Weeding protocol	KAKAI	SNACK-JACK	STYRIACA	SNACK-FACE	STYRIACA
Horticultural weeding	32*	26*	25*	7	5
Field crop weeding	4	4	4	6	4
Crimper-rolled rye mulch	0	0	0	271	159
Biodegradable black mulch	103	79	89	6	4
Hand weeding	160	183	146	230	170
Weed cover control	0	0	0	0	0

* Includes the following hand weeding times: Kakai = 27.4 h/ha ; Snackjack = 21.8 h/ha ; Styriaca = 20.3 h/ha.

Overall, for these weeding protocols, the weedy check and the crimper-rolled rye mulch plots produced the lowest fruit (data not presented) and seed yields. The biodegradable black mulch and mechanical weeding strategies (horticultural and field crop) produced yields statistically similar or slightly below those of the hand weeded control, with the exception of the "Snackjack" cultivar, where yields for mechanical weeding protocols were slightly below yields for hand weeded plots. The 2012 results also demonstrate that when there's only moderate weed pressure, it's possible

to skip the hand weeding steps of the horticultural, mechanical weeding, and biodegradable black mulch protocols with no effect on the yield. Hand weeding operations are costly and must only be employed where yield gains exceed costs incurred.

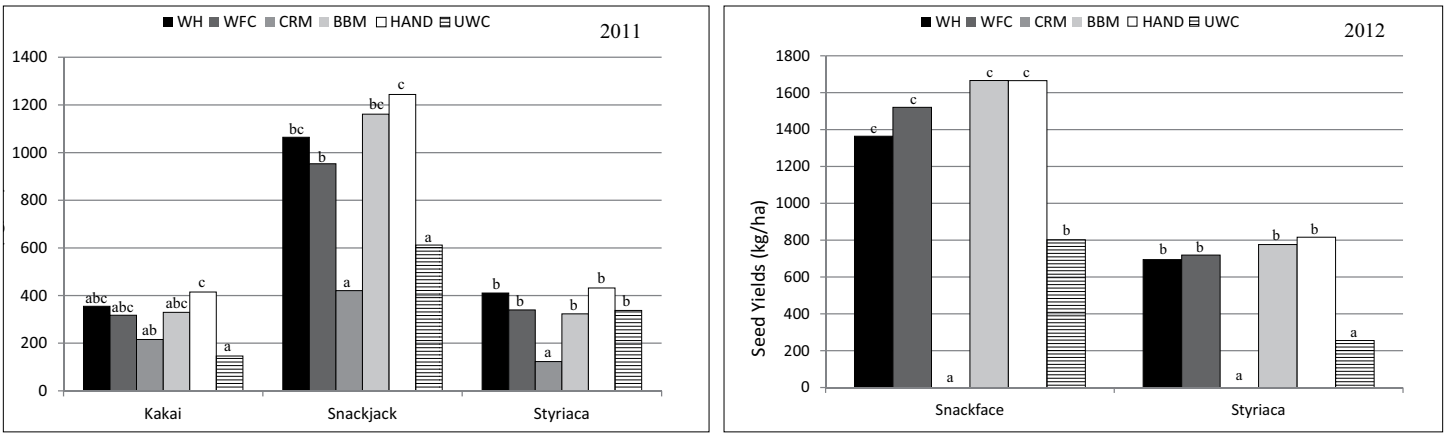

Figure 3. Seed yields for various hulless-seed pumpkin cultivars in 2011 and 2012 using different weeding strategies.
For each cultivar, treatments with the same letter are not significantly different ($p \leq 0.1$).

RYE MULCH: DISAPPOINTING RESULTS

In this organic production project, crimper-rolled rye mulch did not produce the anticipated results. In 2011, the rye provided poor weed control, lasting only about a month. Towards mid-summer many weeds appeared in the rolled rye plots and affected pumpkin plant growth. Furthermore, the crimper-roller's passage did not completely destroy the rye, so allelopathic compounds produced by regrowth may have harmed pumpkin development.

To improve the rye's efficacy, its sowing rate was increased from 125 kg/ha in 2011 to 160 kg/ha in 2012. The rye biomass then ended up between 6 and 9 t/ha during rolling and theoretically should have provided good ground surface cover. Despite the increase, the rye mulch's efficacy against weeds was of short duration, about a month. Thereafter, the hand weeding of seedlings that grew up through the mulch reduced weed density, but their biomass was, nonetheless, significant at the end of the season. Passing twice with the crimper roller was not enough to completely destroy the rye, which once more exerted an inhibitory effect on pumpkin plants. The pumpkin fruit (data not presented) and seed yields for this treatment were therefore quite low, inferior to those of other treatments, including at times the weedy check plot.

IN SUMMARY

- Horticultural- or field crop-type mechanical weeding, as well as the use of biodegradable black mulch provided good weed control.
- These weeding strategies produced yields often similar to those obtained by hand weeding, with considerable savings in weeding times.
- The crimper-rolled rye mulch failed to produce good results under the experimental conditions used in this project.

For more information, visit the IRDA website:
See the summary sheets for Hulless pumpkin seed: a new crop for organic production in Québec
- Part 1 – Cultivars and Planting Methods
- Part 3 – Economic Feasibility

The final report for this project: *Organic Production of Pumpkin Seeds as a Functional Food for the Snack Market and for Processing* (only available in French)

IMPLEMENTATION AND FUNDING PARTNERS

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