Agriculture and Agri-Food Canada
Agriculture et Agroalimentaire Canada

SUSTAINABLE CROP PROTECTION
Results from the *Pesticide Risk Reduction Program*

Field vegetable production:

Using cover crops for weed management

Weed management is an important crop protection component in vegetable production. Non-chemical weed control options are needed to help growers reduce reliance on herbicides and risk of resistance development. Cover crops (CC) have been identified as an approach to sustainable weed management.

Cover crops serve important functions such as enriching soil organic matter, cycling nutrients, and protecting soil from water and wind erosion. Cover crops have also been used as part of an integrated weed management approach.

However, information on CC approaches, applications and benefits pertinent to vegetable crops grown in Canada is not readily available. Therefore, a literature review was conducted to determine the feasibility of using CC in field vegetable production systems as part of integrated weed management practices to minimize the use of herbicides.

Methodology

Published scientific literature and extension articles on CC research for key vegetable crops (potato, sweet corn, field tomato, carrot, onion, Brassica crops, peas, cucurbit crops, green and wax beans, and lettuce) in North America and other regions with similar climates in Europe were reviewed. From this review, approaches which can be adopted for weed management in field vegetable production in Canada were identified based on:

Figure 1. **No-till seeding into a chemically killed rye cover crop**

- Economics
- Potential to suppress weeds by allelopathy (inhibition of growth of a plant by a toxin released from a nearby plant of the same or another species)
- Amount of research that has been conducted for the system in temperate regions
- Environmental impact

Economics included establishment costs, impact on crop yield, and potential for the CC to add value through control of weeds (e.g. reduced herbicide input cost), through control of other pests (e.g. increased yield or reduced input cost of other pesticides) or as a product such as forage.

Canada

Results

Potential to adopt CC as a weed control tool and reduce herbicide use in vegetables has been demonstrated mostly by studies conducted in the US. There are few scientific studies on CC for weed control in vegetables from Europe or Canada. Full season weed control by CC was rare in the literature. Some additional weed control is usually required later in the season.

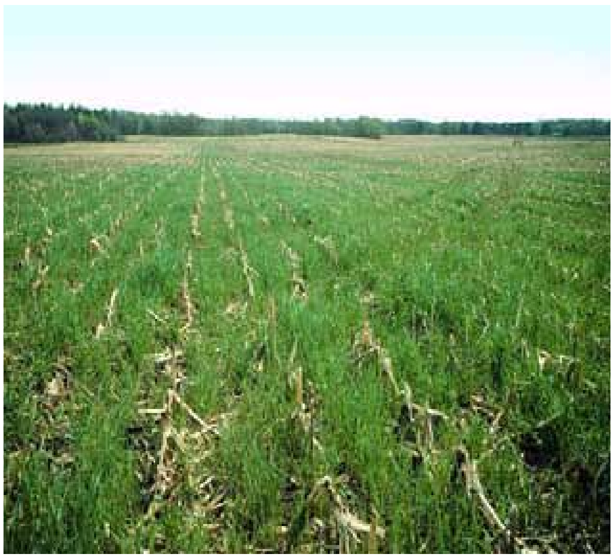

Figure 2. Cereal rye in April that was overseeded by aircraft into a standing crop the previous August

Cover crops can lessen herbicide use by:

- Reducing the number of pre-plant or pre-emerge (PRE) applications;
- Switching from broadcast to band application; and,
- Switching from PRE to post-emerge (POST) applications as needed.

Switching to POST usually involves herbicides that are less persistant in the environment than PRE. Savings in herbicide cost compensates the CC cost in some studies but not others. There is wide variability between studies and systems in degree of weed control, crop response and costs. Some systems add value beyond weed control, thereby increasing profitability.

Species of weeds controlled varies widely between and within systems. In general, annuals, and not biennials or perennials are suppressed by CC. Allelopathy is a promising mechanism of control, and is likely to work best where weeds are small seeded, and the crop is not. Rye residues are allelopathic with better efficacy against annual dicots than grasses and have consistently controlled lambsquarters, nightshade, plantain, goosegrass and barnyardgrass. Brassica residues are also allelopathic, depending on stage, and notably provide control of crabgrass and pigweed. Smother crops such as sorghum or sudangrass can provide control of perennials such as quackgrass during growth, but at the expense of about half of the growing season. Sorghum residues also have allelopathic effects, controlling pigweed, barnyard grass and others.

Figure 3. Measuring biomass of forage sorghum

Recommended approaches

Table 1. Four cover crop systems are recommended for sustainable weed management that can be adopted by Canadian vegetable growers:

<table>
<tr><th></th><th>Cover Crop Approach</th><th colspan="2">Comments</th></tr>
<tr><td>A</td><td>Fall-seeded cereal rye + hairy vetch mixture, chemically killed before no-till tomato</td><td rowspan="3">Rye was selected for these systems because of allelopathy to weeds (Table 2), low seed cost, high availability (in many areas), and compatibility with existing equipment (combine, drill) facilitating home-grown, inexpensive seed. Both rye and vetch grow at low temperature and mixtures provide a number of advantages over monoculture cover crops.</td><td>Hairy vetch adds nitrogen value and has a track record of increasing tomato yield and profit.</td></tr>
<tr><td>B</td><td>Fall-seeded rye chemically killed before zone-till cucurbits</td><td>Zone tillage was selected for this system to avoid delay in crop maturity that can occur with mulches left on the surface.</td></tr>
<tr><td>C</td><td>Aerial overseeded rye into late harvested crops such as potato or carrot</td><td>This system may not increase profit in the short term (1 yr), but may reduce the weed seed bank over the long term, and provides important off-site environmental benefits such as improved water quality.</td></tr>
<tr><td>D</td><td>Summer seeded smother crop of sorghum or sudangrass before or after a short season vegetable such as fresh market cole crops or pea</td><td>Sorghum was selected for this system because it is a smother crop, residues are allelopathic to weeds, it is drought tolerant and therefore suitable for summer planting (typically dry), and it has potential to add value as livestock feed or a biomass crop or from control of other pests in the subsequent vegetable such as root rot.</td><td></td></tr>
</table>

Conclusions

Growers are encouraged to trial rye/vetch mixtures prior to tomato or rye before cucurbits with minimum or no till planting, or cereal rye overseeded into late harvested crops, or sorghum before late planted or after early harvested vegetable crops. Adoption of these recommended approaches will likely lead to reduced need for herbicides, hence reduced risk from pesticides, better resistance risk management and other economical and environmental benefits.

If using any of these approaches, note:

- Vetch should be planted by September. If available water is limited, it is advisable to burndown the rye or rye/vetch mixture in spring before it uses too much moisture. A tank mix may be needed to kill vetch; in this case, a minimum of two weeks is needed before transplanting the new crop. Reducing nitrogen fertilizer rate to subsequent vegetable according to vetch growth is also advisable.
- Mowing the CC may enhance weed control.
- Row cleaners, also called trash whippers, mounted on seeding equipment can improve crop stands when seeding through CC residues.
- Herbicide requirement will be reduced according to amount of mulch left by the CC, existing weed pressure and the weather - spray as needed.

Table 2.
Seeding rates and seeding costs for recommended cover crop species and cost of selected cultural practices.

Species	Seed Rate		Seed Cost		Planting Cost	
	kg/ha	Source	$/kg	Source	$/ha	Source
Rye - drill	125	Reynolds *et al.*, 2002	0.13	Ontario	$16.20	Reynolds *et al.*, 2002
Rye - drill	120	New Brunswick, Quebec	0.79	New Brunswick, Quebec	$95.00	New Brunswick A&A 2008 (online)
Rye - drill	62-94	Hoffman and Regnier, 2006			$52.00	Wilson, 2005
Rye - aerial	125	Manitoba AFRI online (in potato)				
Rye - aerial	188	Ball Coelho *et al.*, 2005 (in corn)		commodity price, Ontario	$24.70	
Hairy vetch	20-30		2.75		$68.75	VerHallen *et al.*, 2003
Hairy vetch	28-45	Hoffman and Regnier 2006; Abdul-Baki and Teasdale, 2007			$148.00	Wilson, 2005
Hairy vetch	30		4.76		$143.00	New Brunswick A&A 2008 (online)
Rye + vetch	95-125 (rye) 28-45 (vetch)				$105.00	Snapp and Mutch, 2003
Rye + vetch	35 (rye) 28 (vetch)	Groff online				
Rye + vetch	45 (rye) 45 (vetch)	Abdul-Baki and Teasdale, 2007				
Rye + vetch	45-123 (rye) 19-28 (vetch)	Burgos *et al.*, 2006; Masiunas, 2006				
Sorghum sudangrass	15		$1.68	New Brunswick A&A 2008 (online)	$25.00	New Brunswick A&A 2008 (online)
Forage sorghum	15	Wheeler and McKinlay, 2007	$4.84	Ontario	$ 72.60	

Table 3. Example costs of some relevant field operations used in establishing a Example costs of some relevant field operations used in establishing and killing cover crops based on custom rates. nd killing cover crops based on custom rates.

Operation	Cost $/ha	Source
Grain drill	$28	Reynolds *et al.*, 2002
Air seed	$50	Manitoba AFRI online
NT drill	$46	Reynolds *et al.*, 2002
Mow	$12	Reynolds *et al.*, 2002
Incorporation	$11	Reynolds *et al.*, 2002
Spray	$22	2009 retail, ON
Cultivate	$17	Ball Coelho *et al.*, 2003

Table 4. Example input costs from Wallace and Bellinder (1992) study in New York with tomato strip tilled into different cover crop mulches and metribuzin/sethoxydim applied as needed.

Cover crop species	Cover crop kill method	Cost $/ha (seed & kill)	Cost $/ha (herbicide; * 2 applications)
Grain rye	glyphosate 1.1 kg ai/ha	$84	$121
Hairy vetch	mow kill	$193	$230
Annual ryegrass	winter killed, glyphosate / 2,4-D for emerged perennials	$111	$158*
Conventional till	plow, disc	$57	$94

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About the *Pesticide Risk Reduction Program* at *Agriculture and Agri-Food Canada*

The Pesticide Risk Reduction Program delivers viable solutions for Canadian growers to reduce pesticide risks in the agricultural and agri-food industry. In partnership with the Pest Management Regulatory Agency of Health Canada (PMRA), the Program achieves this goal by coordinating and funding integrated pest management strategies developed through consultation with stakeholders and pest management experts.

The Pesticide Risk Reduction Program is actively pursuing the development and implementation of strategies which are key to reducing pesticide risks in the agricultural environment. To view Program's current priorities and the issues being addressed, visit: www.agr.gc.ca/prrmup. To consult other factsheets in this series, visit: www.agr.gc.ca/sustainable-crop-protection.

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