IPM IN PRACTICE

Contents

Cover cropping for weed suppression

Cover crops are primarily grown to provide ground cover to control soil erosion, increase organic matter, improve soil structure and tilth, fix nitrogen and increase the productivity of the soil. Cover crops can also be used to suppress weed growth. They are normally grown prior to the planting of a cash crop, and in the case of weed suppression, the organic matter of the cover crop is kept in place during the growth of the subsequent cash crop.

Weeds thrive on bare soil, so the aim of a cover crop is to shade and restrict light to newly emerging weeds. This basically creates a physical barrier for weeds. However, some cover crop plants may also suppress weed emergence through allelopathy - that is, they inhibit or slow the growth of weeds by releasing natural toxins into the soil. Winter rye, ryegrasses and subterranean clover are all thought to have some allelopathic affect. Other non-allelopathic cover crops that can be used are oats, legumes, wheat and vetch. An integrated weed management approach that supplements the use of cover crops with timely herbicide application and soil cultivation is often required for the most effective results.

Figure 2.1 Rye corn cover crop. The arrows indicate the two rows left for the broccoli transplants.

Case study: Rye corn cover crop in broccoli

In many cases cover crops can replace, or at least reduce the need for, other pre- and post-emergent weed management techniques such as inter-row cultivation and herbicide application. In this case study, broccoli was planted into a rye corn cover crop. Weed suppression was so effective that no mechanical or chemical weed management tools were required.

How was it done?

The demonstration described here used a dead mulch cover crop, as opposed to a living green mulch cover crop. Rye corn cereal was selected for its reported allelopathic effect and dense biomass. Most crops that are transplanted, such as brassicas, and large seeded crops like pumpkins, can tolerate allelopathic cover crops. Small seeded crops, such as carrots and onions, are better suited to non-allelopathic crops like oats.

Figure 2.2 After the cover crop was rolled the broccoli was transplanted.

The rye corn was sown directly into a prepared stale seed bed. Two rows were left free of cover crop for subsequent transplanting of the broccoli, as indicated by the orange arrows in Figure 2.1. Access to specialised equipment suited to direct placement of transplants into a mulch cover would have allowed a complete cover and not required the two blank rows. Fertiliser for both the cover crop and broccoli crop was directly drilled with the sowing of the cover crop.

Figure 2.3 Broccoli in a rye corn cover crop.

The cover crop was left to grow for 6-10 weeks, by which time it had reached a height of 1 - 1.3 metres. The rye corn was then sprayed off with glyphosate. Once the crop was desiccated, it was rolled flat and the broccoli immediately transplanted into the blank rows that had been left in the cover crop (Figures 2.1, 2.2 and 2.3).

How much did it cost?

It was estimated that the rye corn cover crop cost $69.75 per hectare in labour, seed, chemical and machinery (Figures 2.4 and 2.5). However, traded off against this cost is a total saving on herbicide applications during the growth of the broccoli crop, and a number of indirect and long term benefits and savings such as improved soil structure, improved water management and erosion control.

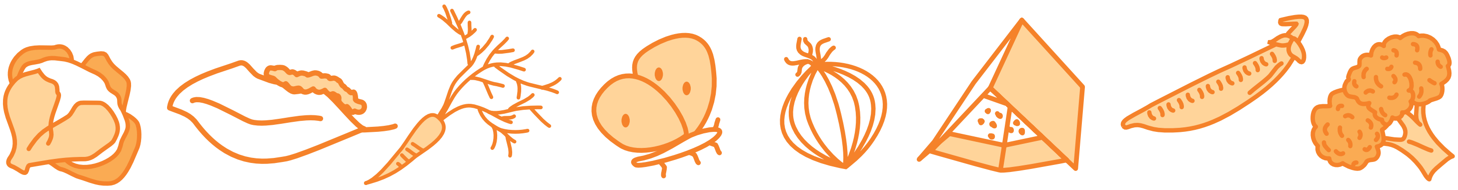
Weed management in brassicas is usually not a significant problem. Weeds are usually managed by inter-row cultivation and hand hoeing during the growth of the crop. Using a cover crop may not directly save money, but it can eliminate the need for any form of weeding, along with the added advantages of improving a number of long term soil and crop benefits, as mentioned previously.

For crops such as onions, up to 14 applications of pre- and post-emergent herbicides are often applied, costing an average of $387/ha. A cover crop of oats may reduce this cost by eliminating a number of herbicide applications.

For crops such as pumpkins, where the crop rests on bare soil, a cover crop may reduce soil-scarring damage by providing a mulch mat on which the crop rests. This can be important from an aesthetic and market viewpoint.

Item	Amount	Cost/Unit	Cost/ha
Drilling cover crop	1 hr/ha	$14.15 /hr	$14.15
Rye corn cereal	10 kg/ha	$1.30 /kg	$13.00
Glyphosate	0.15 l/ha	$9.00 /l	$1.35
Rolling	0.8 hr/ha	$4.71 /hr	$3.75
Spraying	0.6 hr/ha	$5.48 /hr	$3.30
Labour	2.5 hr/ha	$13.68 /hr	$34.20
Approximate cost per hectare			$69.75

Figure 2.4 Approximate cost per hectare associated with planting a rye corn cover crop.



Crop	Herbicide & no. sprays	Amount used	Approx cost/ha
Green beans	Pre emergent		
	Pendimethalin - 1 spray	1.5 l/ha	$15
	Post emergent - broad leaf control		
	Bentazone - 2 sprays	1.5 l/ha	$131
	Grass control		
	Fluazifop-butyl - 1 spray	1.0 l/ha	$124
Approximate herbicide costs in green beans ($/ha)			$270
Onions	Pre emergent		
	Pendimethalin - 1 spray	1.0 l/ha	$10
	Diquat - 1 spray	1.5 l/ha	$20
	Post emergent - broad leaf control		
	Pendimethalin - 1 spray	2.0 l/ha	$20
	Tribunil - 2 sprays	500 g/ha; 1.0 kg/ha	$129
	Totril - 3 sprays	500 ml/ha; 750 ml/ha x 2	$97
	Cyanazine - 1 spray	750 ml/ha	$49
	Grass control		
	Haloxyfop-ethoxy-ethyl - 1 spray	200 ml/ha	$62
Approximate herbicide costs in onions ($/ha)			$387
Carrots	Pre emergent		
	Pendimethalin - 1 spray	3.0 l/ha	$29
	Diquat - 1 spray	1.5 l/ha	$20
	Post emergent - broad leaf control		
	Linuron - 2 sprays	500 g/ha	$49
	Prometryn - 2 sprays	120 g/ha	$38
	Grass control		
	Fluazifop-butyl - 1 spray	1.0 l/ha	$124
Approximate herbicide costs in carrots ($/ha)			$260
Peas	Pendimethalin - 1 spray	3 l/ha	$29
	Bentazone - 1 spray	1.5 l/ha	$66
	Cyanazine - 1 spray	1.5 l/ha	$100
Approximate herbicide costs in peas ($/ha)			$195
Potatoes	Pre emergent		
	Prometryn - 1 spray	3.0 l/ha	$28
	At emergence		
	Diquat - 1 spray	2.0 l/ha	$26
	Metribuzin - 1 spray	500 g/ha	$41
	Early post emergence		
	Metribuzin - 1 spray	300 g/ha	$25
Approximate herbicide costs in peas ($/ha)			$120

Figure 2.5 *Approximate cost of herbicides that could be reduced or elimated in various crops through the use of cover crops. (Figures are industry standards gathered through consultation with Tasmanian agronomists)*

Commonly asked questions:

What other types of cover crops can you use?

Cereal crops such as rye and barley, as well as vetches and clovers, produce a good biomass and can be effective in suppressing weeds. Two or more crops can be used in combination to maximise the benefits of cover cropping. Vegetable crops that need high levels of nitrogen will benefit from cover crops high in nitrogen, such as leguminous and clover crops. As these crops tend to decompose rapidly, including rye or barley in the mix will improve the level of weed suppression, while the legume crop will supply nitrogen to the vegetable crop. It is recommended that you consult your local rural adviser for advice on varieties.

Does the cover crop have an impact on soil water and nutrient levels?

Planting leguminous crops can replace some or all of the nitrogen fertiliser needed to grow a vegetable crop. Soil structure can be significantly improved as soil is not left bare during fallow periods. Cover crops will also reduce soil run off during rainfall along with increasing the organic matter content of the soil, which in turn improves water infiltration.

Insect exclusion netting

Insect exclusion netting is a physical barrier to exclude flying insect pests, such as aphids and moths, from feeding on and damaging the host crop. The exclusion net is a fine, lightweight, water permeable fabric that is laid over the crop to protect the crop against insect infestation (Figures 2.6 and 2.7). The netting can protect the crop from frost damage, reduce loss of soil moisture through evaporation and increase soil temperatures, which then encourages early plant growth. Insect netting can be used on most vegetable crops, but is more suited to the small scale organic producer, as ongoing maintenance is often required.

Figure 2.6 The fine, permeable insect netting used on broccoli.

Case study: Insect exclusion netting in broccoli

Insect exclusion netting can reduce the need for insecticide applications for various flying pests. In this case study, insect exclusion netting was used with broccoli to prevent diamondback moth, aphids and cabbage white butterfly from attacking the crop. Crops that were planted without the netting required numerous insecticide applications to control such pests.

How was it done?

The netting was placed over the crop beds as soon as the broccoli had been transplanted. The netting was installed manually by unrolling it over the rows and digging in or pegging down the edge to prevent it from lifting in the wind. Small plastic hoops were placed under the netting to keep it off the crop. This may not be essential, but it seemed to increase wind movement through the crop and prevented the net from resting on the crop following irrigation. Ongoing maintenance was often required as the net needed to be released at the edges to allow for crop growth.

Figure 2.7 Insect exclusion netting a broccoli crop.

How much did it cost?

It was estimated that an additional $2512 per hectare would be required for installation of the insect exclusion netting (Figure 2.8). The labour costs of installing insect netting are high and therefore it may be uneconomical in most conventional vegetable production systems. However, with improved methods of mechanical installation and better durability of the netting, it may eventually prove useful in conventional agriculture.

For small-scale organic vegetable production, this method can be an extremely useful insect management tool, as the area planted using netting did not require any insecticides. Figure 2.9 shows potential savings that could be made on insecticides if the insect exclusion netting was used. The figures do not include labour and machinery savings.

Item	Amount	Cost/Unit	Cost/ha
White netting	1000 m x 3.2m	$0.17 /m^2	$1718.75
Labor for installation, removal & upkeep	48 hours	$13.68 /hr	$656.64
Tractor / plant to install	10 hours	$13.68 /hr	$136.80
Approximate cost per hectare			$2512.19

Figure 2.8 Approximate costs that would be incurred if installing netting by hand. NB Labour costs may increase if the netting needs to be removed for the management of weeds and diseases.

Crop	Insecticide & no. sprays	Amount used	Approx cost/ha
Broccoli	*Bacillus thuringiensis* - 2 sprays	750 g/ha	$112
	Spinosad - 1 spray	800 ml/ha	$163
	Emamectin benzoate - 1 spray	300 g/ha	$135
	Indoxacarb - 1 spray	250 g/ha	$82
	Pirimicarb - 1 spray	500 g/ha	$40
Potential pesticide savings in broccoli ($/ha)			$532
Onions	Pre emergent		
	Chlorpyrifos - 1 spray	700 ml/ha	$16
	Alpha-cypermethrin - 1 spray	400 ml/ha	$10
	Dimethoate - 1 spray	600 ml/ha	$10
Potential pesticide savings in onions ($/ha)			$36
Carrots	Chlorpyrifos - 2 sprays	700 ml/ha	$32
Potential pesticide savings in carrots ($/ha)			$32
Green beans	Chlorpyrifos - 1 spray	1.0 l/ha	$20
	Esfenvalerate - 2 sprays	1.0 l/ha	$100
Potential pesticide savingss in green beans ($/ha)			$120

Figure 2.9 Potential insecticide savings that could be made when using insect exclusion netting. These figures do not include savings on machinery or labour. (Figures are industry standards gathered through consultation with Tasmanian agronomists)

Commonly asked questions

Did the netting impact on weed growth and disease development?

The netting was effective in eliminating insects. However, the conditions under the netting were similar to a glasshouse, in that the microclimate under the netting was warm and humid. This became ideal for weed growth and potential disease development.

The netting needed to be removed for disease and weed management operations. This resulted in increased labour costs associated with removing and replacing the insect netting. It is possible that weed growth could be reduced with the use of a dense cover crop. Using hoops to lift the netting off the crop, thereby improving air movement, could reduce disease levels.

Crop monitoring

Crop monitoring, or scouting, is the most important tool used in any IPM program. It is the tool that provides specific information on pest activity in the crop. Crop monitoring is explained in greater detail in the first section of this manual.

Case study: Pest monitoring in broccoli

Crop monitoring in broccoli can significantly reduce the need to apply insecticides. In this case study, a 3 hectare broccoli crop was monitored once or twice weekly mostly for insect pests and beneficials. Any signs of diseases and heavy weed infestations were also noted.

Figure 2.10 Inspecting a pheromone trap whilst monitoring broccoli.

How was it done?

A crop monitoring recording sheet was developed similar to the one found in the crop monitoring section in the first chapter of this manual. Two pheromone traps were placed in the paddock to monitor diamondback moth (DBM) flight activity (Figure 2.9), and two yellow sticky mats were placed in the crop to monitor beneficial activity.

The crop was inspected once a week during low pest pressure periods and twice a week during high pest pressure periods. Twenty-five broccoli plants were monitored each time. The plants were randomly selected while walking a large zigzag pattern through the crop.

The 'presence and absence' method was used to monitor the plants. This involved looking at the plant and noting a '✓' for "yes" on the recording sheet if there was any sign of live grubs, fresh feeding holes or fresh grub droppings. It is also worth noting if any eggs are present and if the number of eggs is high or low. Any sign of beneficial insect activity was also noted and given a rating of low, medium or high.

How were the result interpreted?

Following each monitoring session, the percentage of plants infested was determined and then displayed on a graph (Figure 2.11) showing diamondback moth (DBM) level. The red stars on the graph indicated when an insecticide was applied. Plant growth stage, level of pest infestation and beneficial numbers determined when or if a spray was required. In this case the first insecticide was applied at close to 60% of DBM infestation, just as the curd started to develop. This may seem high, but prior to curd formation the plant can tolerate a significant amount of feeding damage. Also, delaying the onset of spraying allows pest numbers to increase, which is necessary for the beneficial insect population to grow.

The second application was applied eight days after the first. This time, a higher water volume (>400 l/ha) was used to increase coverage in and around the head. This resulted in pest pressure dropping to 0% up until harvest. Allowing the beneficial insects to build up in the crop, and choosing insecticides that protect beneficials assisted in managing the pest level.

When monitoring is not used, insecticides are often applied every 10-14 days regardless of the level of pest activity. This can lead to build up of resistance to pesticides, loss of beneficial insects and increases in pesticide costs. This case study showed that only two insecticides were required to manage the pest during an extremely high pest pressure period. Had crop monitoring not been done, there would probably have been at least three to five applications of insecticides.

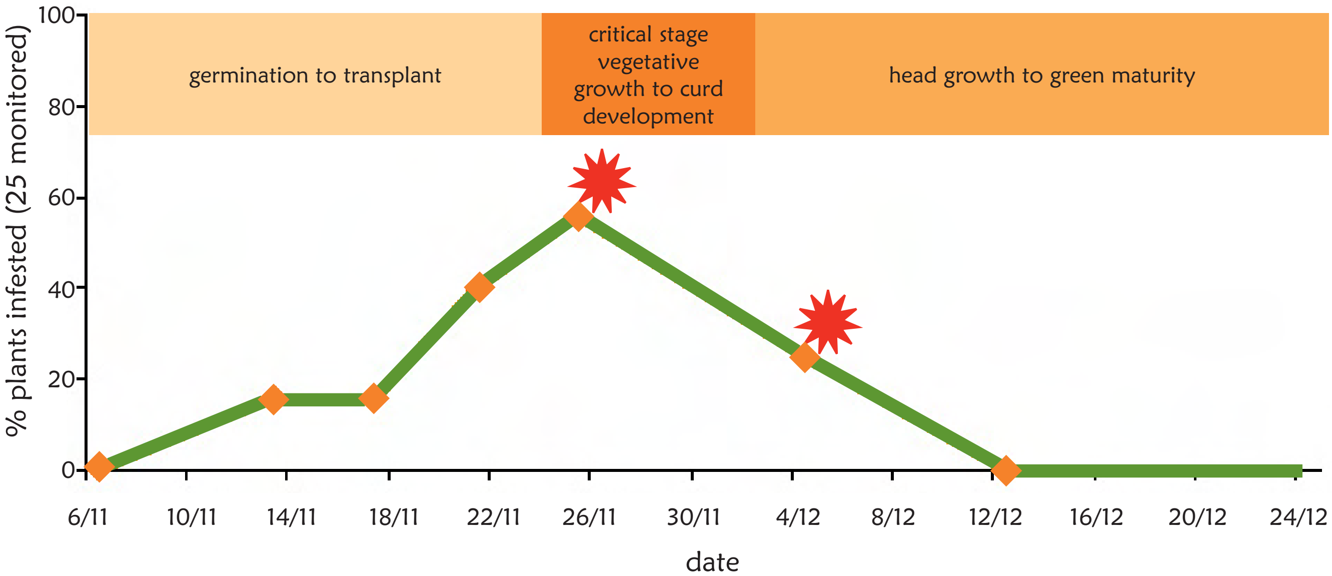


Figure 2.11 Diamond back moth monitoring case study conducted at Forthside Research and Demonstration Station on a commercial fresh market broccoli crop.

Brush weeding for weed management

The brushweeder uses a series of spinning brushes to remove small weeds from between the rows of crops such as onions, peas, carrots, lettuce, beans, potatoes and brassicas (Figures 2.12 and 2.13). Using a brushweeder can significantly reduce the need for post-emergence herbicides, although repeated use may damage surface soil structure.

Figure 2.12 Metal guards protect the crop from the brushes.

How does it work?

The brushweeder has a series of brushes mounted on a horizontal axle at right angles to the direction of the row. The brushes are positioned along the axle to weed the area between the rows. The crop is protected from the turning brushes by metal guards (Figure 2.12). The guards and brushes can be manually changed to suit the row spacing and the specific growth stage of the crop. Brushweeding usually commences after emergence and can continue up until the crop becomes too large for the guards to pass over the rows.

Figure 2.13 Brush weeding a carrot crop.

Soil conditions at the time of weeding have a large influence on the success of the operation. Soil that is too wet will allow weeds to re-strike, and will also clog the brushes. Soil that is too dry can be easily eroded by the wind. Also, weeds are often more difficult to remove from dry soil. Slightly moist soil tends to suit the brushweeder best.

The number of times a crop will need to be brush weeded depends on weed density and the rate of crop canopy growth, but up to four passes may be required. Figure 2.14 shows the extent of 'inter row' weed removal (between the rows) by the brushweeder. The 'intra-row' weeds (the weeds between each plant in the row) are not brushweeded and other forms of weed management are then required. Flame weeding (refer to weed section) prior to crop emergence may reduce intra-row weeds.

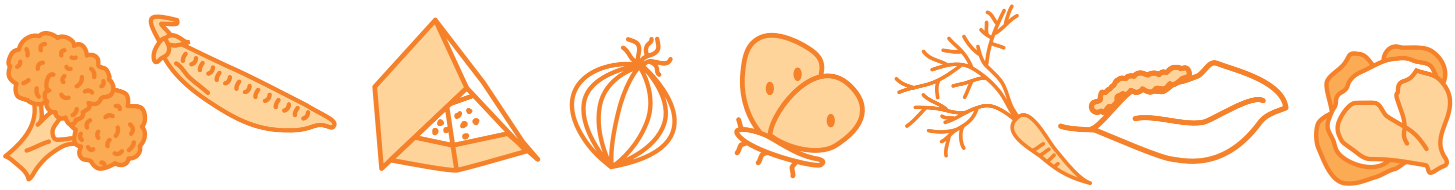
As well as removing weeds, brush weeding can eliminate some soil borne pests, such as cutworm. The brushes are thought to pulverise the grub, which sits on or just below the soil surface during the day.

Figure 2.14 The right-hand side has been brush weeded, the left-hand side is untouched.

How much does it cost?

Figure 2.16 indicates it would cost approximately $155 per hectare for a single brush weeding operation. This cost includes labour for two people (one to drive the tractor, the other to operate the weeder) and the tractor running costs. The initial capital cost of the brushweeder would be around $15,000.

By referring to Figure 2.15 you can identify possible savings that could be made by using brushweeding instead of, or in conjunction with, herbicide applications. The figures do not include savings in labour and machinery.



Crop	Herbicide & no. sprays	Amount used	Approx cost/ha
Green beans	Pre emergent		
	Pendimethalin - 1 spray	1.5 l/ha	$15
	Post emergent - broad leaf control		
	Bentazone - 2 sprays	1.5 l/ha	$131
	Grass control		
	Fluazifop-butyl - 1 spray	1.0 l/ha	$124
Approximate herbicide costs in green beans ($/ha)			$270
Onions	Pre emergent		
	Pendimethalin - 1 spray	1.0 l/ha	$10
	Diquat - 1 spray	1.5 l/ha	$20
	Post emergent - broad leaf control		
	Pendimethalin - 1 spray	2.0 l/ha	$20
	Tribunil - 2 sprays	500 g/ha; 1.0 kg/ha	$129
	Totril - 3 sprays	500 ml/ha; 750 ml/ha x 2	$97
	Cyanazine - 1 spray	750 ml/ha	$49
	Grass control		
	Haloxyfop-ethoxy-ethyl - 1 spray	200 ml/ha	$62
Approximate herbicide costs in onions ($/ha)			$387
Carrots	Pre emergent		
	Pendimethalin - 1 spray	3.0 l/ha	$29
	Diquat - 1 spray	1.5 l/ha	$20
	Post emergent - broad leaf control		
	Linuron - 2 sprays	500 g/ha	$49
	Prometryn - 2 sprays	120 g/ha	$38
	Grass control		
	Fluazifop-butyl - 1 spray	1.0 l/ha	$124
Approximate herbicide costs in carrots ($/ha)			$260
Peas	Pendimethalin - 1 spray	3 l/ha	$29
	Bentazone - 1 spray	1.5 l/ha	$66
	Cyanazine - 1 spray	1.5 l/ha	$100
Approximate herbicide costs in peas ($/ha)			$195
Potatoes	Pre emergent		
	Prometryn - 1 spray	3.0 l/ha	$28
	At emergence		
	Diquat - 1 spray	2.0 l/ha	$26
	Metribuzin - 1 spray	500 g/ha	$41
	Early post emergence		
	Metribuzin - 1 spray	300 g/ha	$25
Approximate herbicide costs in potatoes ($/ha)			$120

Figure 2.15 Approximate costs of herbicides that could be reduced or eliminated in various crops through brush weeding. (Figures are industry standards gathered through consultation with Tasmanian agronomists)

Item	Amount	Cost/Unit	Cost/ha
Labour - 2 people	3.5 hours	$13.68 /hr	$95.75
Tractor / plant	3.5 hours	$6.55 /hr	$22.95
Approximate cost per hectare			$118.70

Figure 2.16 Estimated brush weeding costs per operation. NB Two to four runs may be required and this does not include the cost of the brush weeder.

Commonly asked questions?

The brush weeder removes inter-row weeds (weeds in between the rows) but what about intra-row weeds (weeds between the plants in the row)?

The brushweeder is not suitable for removing intra-row weeds. When the crop is very young, the brushes and guards can be set to weed very close to the row, but the brushweeder has no capacity to impact on the weeds in the row.

Intra-row weeds are difficult to manage mechanically without causing damage to the crop. In many European countries, changes to planting architecture have been made to enhance physical intra-row weed management. Single row planting, as compared to twin rows, was found to reduce intra-row weeds and enabled more efficient inter-row mechanical weeding.

The use of transplant vegetables is also an advantage in controlling intra-row weeds. The plants are stronger and can withstand more aggressive mechanical weeding compared to newly emerged seedlings. In some crops (eg sweet corn, brassicas) it is possible to have some control over intra-row weeds by ridging or inter-row harrowing. When the inter-row weeding operation is performed, soil is shifted into the intra-row zone and smothers small weed seedlings. The larger crop plants can survive with up to 20% soil cover and still grow. This approach can be used with a number of crops when the growth stage is such that the crop plant is large enough or strong enough to cope with soil being ridged around its base.