HORTICULTURE

Biofumigation Update

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Potato Grower's Positive Experiences With Biofumigant Green Manure

Potato grower **Geoff Hobson** from Thorpdale in Gippsland, Victoria has recently related his experiences in using mustard as a biofumigant green manure in his intensive rotation. The practical information should be of wide interest.

Geoff plants potatoes in about October each year, harvesting in February-May. Annual average rainfall is about 950 mm, winter-dominant.

As soon as the field is cleared and waste tubers eaten by sheep, the land is prepared for sowing mustard in May-June. The soil, which is friable red volcanic clay with good water infiltration characteristics, is cultivated using a chisel plough.

Fig. 1. Pulverising mustard green manure.

The fine seed bed needed for the small mustard seeds is obtained with a power harrow working to about 7-10 cm. The seeder is piggy-backed onto the power harrow, dropping the seed behind, and the combination has a trailing roller.

The roller is made from solid rubber fork-lift tyres, in place of the conventional metal cage roller, to firm the seeded bed. However, Geoff feels that pneumatic tyres would be better.

The mustard is grown for about 100 days, until early flowering. It is then mulched using a 4.5 m wide 4-row profiled pulveriser normally used to destroy potato stems in preparation for harvest.

Because this implement is set up with short and long blades to follow the contours of the hilled potato beds, Geoff changes some of the blades to obtain uniform lengths.

The pulveriser then works uniformly across the flat surface in which the mustard is grown. This maximises the utility of the implement and avoids the need for a separate mulcher.

Immediately after pulverising, the mustard is incorporated into the soil using a mouldboard plough. It is then left for about one month before being disc ploughed at least 2-3 times at approximately two-week intervals.

A deeper cultivation is then carried out with a chisel plough. In preparation for planting potatoes, a four-row bed former is then used to form the hills, and the annual cycle resumes.

Usually the mustard is not sown with fertiliser as there is sufficient left after the potato crop, depending on the field's history. About 50 Kg/ha of urea is spread when the mustard is around 30 cm high.

Geoff feels that the *Brassica* rotation needs to go through about three cycles before achieving optimum results.

He has been using mustard in this rotation for the last five years, on land that has been in potato production for 15 years without a total break, and he is very satisfied with potato yields and quality.

Previous rotations have included winter wheat, but Geoff is happier with the mustard.

The only drawback Geoff notes is that the pulverised mustard carries with it a lot of moisture into the soil when ploughed in.

He is trying to reduce the impact of this by pulverising a little earlier before the mustard develops too much biomass, to give more time between ploughing and planting potatoes.

Figure 1 shows the mustard being mulched. The .jpg file of the colour photographs is moderately large (1.2 Mb), but those who would like them e-mailed, please e-mail John.Matthiessen@csiro.au. Alternatively, view them in *Biofumigation Update 16* at: http://www.ento.csiro.au/research/pestmgmt/biofumigation/newsletter_list.html.

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The horticultural and grains industries are supporting research on the biofumigation concept through Horticulture Australia & GRDC.

Horticulture Australia GRDC

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Horticulture Pests and Diseases

Successful Use of Biofumigant Green Manure Crops for Soilborne Disease Control

Recent field trial studies on green manure crops by **Hoong Pung, Susan Cross** and **Dennis Patten** of Serve-Ag Research in Tasmania have shown that biofumigant green manure crops could increase marketable yields of subsequent lettuce crops by reducing tipburn, bacterial rot, and *Sclerotinia* disease. The benefits appear to depend on local soil conditions and the type of crop used.

Green manures were sown in July 2001 and rotary hoed to 25cm when the mustard, rape and broad beans were flowering in October-November. Lettuces were planted in December 2001 (Trial 2) and January 2002 (Trial 1).

Trial 1 was located at Cambridge, in an area that has a history of lettuce production and severe *Sclerotinia* disease. Trial 2 was located in Forth in an intermittently cropped paddock with a low level of *Sclerotinia*.

These differences were reflected in the initial sclerotia count in soil samples collected from the two sites at the beginning of the trial, before green manure crops were sown. The Trial 1 site had relatively high levels of *S. minor* sclerotia, while very few or no sclerotia were found in the Trial 2 area (Table 1 & 2).

In Trial 1, the biofumigants BQ-Mulch and Fumus significantly reduced the percentage of plants with *Sclerotinia* wilt (Table 1). BQ-Mulch appeared more effective than Fumus in reducing wilted plants. Oats and broad beans had little or no effect.

Table 1. Effects of green manures on *Sclerotinia minor* sclerotia and disease in a subsequent lettuce crop. Trial 1.

	Mean no. sclerotes/200g soil		
Treatment	Initial count (5/7/01)	Final count (1/3/02)	% plants with *Sclerotinia* wilt
Untreated control	26	10	31c
Oats	16	nt	23bc
Broad bean	15	11	24bc
Fumus	16	9	17ab
BQmulch	25	7	3a

Values with same letter are not significantly different at 5%. nt-not tested.

In Trial 2, at close to commercial harvest, the lettuce plants had a relatively high incidence of tipburn and/or bacterial rot, which was reduced by the Fumus, resulting in a increase in the percentage of marketable lettuces (Table 2).

BQ-Mulch, broccoli and broad beans had little or no effect on tipburn and/or bacterial rot, and hence did not significantly increase the marketable yield compared to the untreated control.

Bacterial rot often occurred on the inner leaves of plants also showing tipburn. Tipburn on inner lettuce leaves is usually attributed to calcium deficiency, which also makes them susceptible to bacterial rot.

The biofumigant crops used in the trials were selected through conventional breeding for their high levels of isothiocyanates (ITCs). Apart from any biofumigation effects, the crop residues also increase organic matter and nutrients, and improve soil structure. Fumus is a variety of mustard, while BQ-Mulch is two rapes.

In both field trials, Fumus matured and flowered approximately two weeks earlier than BQ-Mulch. Analysis of the biofumigant plant samples from Trials 1 & 2, collected prior to green manure incorporation into soil, showed that Fumus produced higher levels of ITCs on their shoots, whereas most of the ITCs for BQ-Mulch were in the roots (Table 3).

The better *Sclerotinia* disease control with the BQ-Mulch plants may be due to the higher ITC levels in their roots. The biofumigant plants from Trial 1 produced much lower levels of ITCs than plants from Trial 2.

Table 2. Effects of green manures on subsequent lettuce marketability. Trial 2.

Treatment	Initial count (19/7/01) Mean no. sclerotes/200g soil	% marketable lettuces	% unmarketable: % tip burn & soft rot	% unmarketable: % other*	% unmarketable: % *Sclerotinia*
Untreated control	0	72a	24	4	0.4
Broccoli	0.3	78a	19	3	0
Broad bean	0	79a	19	1	0.9
Fumus	0.3	88a	9	3	0.9
BQmulch	0	74a	22	4	0

*Values with same letter are not significantly different at 5%. *Plants rejected due to physiological disorder.*

These differences may be due to the different soil types, where the crops were sown in poor clay loam soil at Cambridge, compared to the rich, friable ferrosol soil at Forth.

In the final assessment for sclerotia levels in soil from Trial 1, even though BQ-Mulch and Fumus plots tended to have lower sclerotia levels, the differences between these and other treatments were relatively small (Table 1).

Table 3. Total ITC concentration in plants (µmol/g)

Trial	Variety	Tissue	ITC conc'n
1	BQ	Shoot	2.7
		Root	16.6
	Fumus	Shoot	6.1
		Root	5.9
2	BQ	Shoot	2.7
		Root	42.2
	Fumus	Shoot	32.2
		Root	23.4

This indicated that biofumigation by BQ-Mulch and Fumus appeared to have little effect on the sclerotia viability in the soils. It is possible that the biofumigant crop residues act by inhibiting the mycelial growth of the pathogen instead.

At the end of the trials, when the lettuce crops were ready for commercial harvest, relatively high levels of BQ-Mulch and Fumus crop residue were still evident in the trial areas. In contrast, there was little or no broad bean, broccoli or oat crop residue left in the soil.

The noticeable improvement of the poor clay loam soil structure, with reduced crusting and cracking of soil surface and better water infiltration, especially in the BQ-Mulch plots in Trial 1, may be due to the slow decay of *Brassica* crop residues. The long-term effect of the remaining *Brassica* crop residue on the mycelial growth of *Sclerotinia* is unknown.

In both trials, the broad beans generated relatively high quantities of crop residues, similar to those of the *Brassica* plants. The differences observed in the soilborne diseases appeared to be related to the increased organic matter alone.

These trials were conducted as part of a three-year project funded by the vegetable growers' levy and Horticulture Australia Ltd. Plant analysis for isothiocyanates was conducted by Mark Shackleton at CSIRO Entomology, Perth.

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