Integrated weed management

How cover cropping can improve its use for vegetable growers

University of New England

Hort Innovation
Strategic levy investment

VEGETABLE FUND

Integrated Weed Management

How cover cropping can improve IWM for vege growers

Paul Kristiansen, Michael Coleman, Chris Fyfe UNE

Integrated weed management in practice

Key strategies

- Plan, do and review

Identify your weeds

Managing the weed seedbank is the goal

- Diverse, avoid patterns

Use multiple strategies

- Be strict about hygiene

Prevent translocation of weed seeds!

- Diligence and timing

A stitch in time saves 9 … thousand!

Planting a leek crop into stale seed beds

Integrated weed management

Tools

Use multiple strategies (diversity), and **plan** ahead

- Hygiene - machinery washdown, starting on clean paddocks
- Cultural - Crop rotation to reduce seed bank, break cycles
- Mechanical - Early inter-row weed control (herbicide or cultivation)
  - Hand weeding (chipping)
- Biological - Biofumigant cover crops
- Chemical - Herbicides (pre-plant, selective)
- Other - Plastic mulch, Thermal control

Cover crops as part of crop rotation

- Vary the crops grown, reduce seed bank, break cycles
- Different families have different needs and timings
- Enable different weeding methods to be used
- Benefits for pest & disease management
- Benefits for soil

Cover crops

- Physical competition: quick growing, dense cover such as ryegrass & other cereals, some legumes
- Biofumigation: relies on chemicals from the cover crop to supress weeds (and soil pests), tricky to manage, only targets certain weeds, e.g. brassicas
- Issues: poor establishment, termination, weediness, lost income. BUT, these issues can be addressed through management choices

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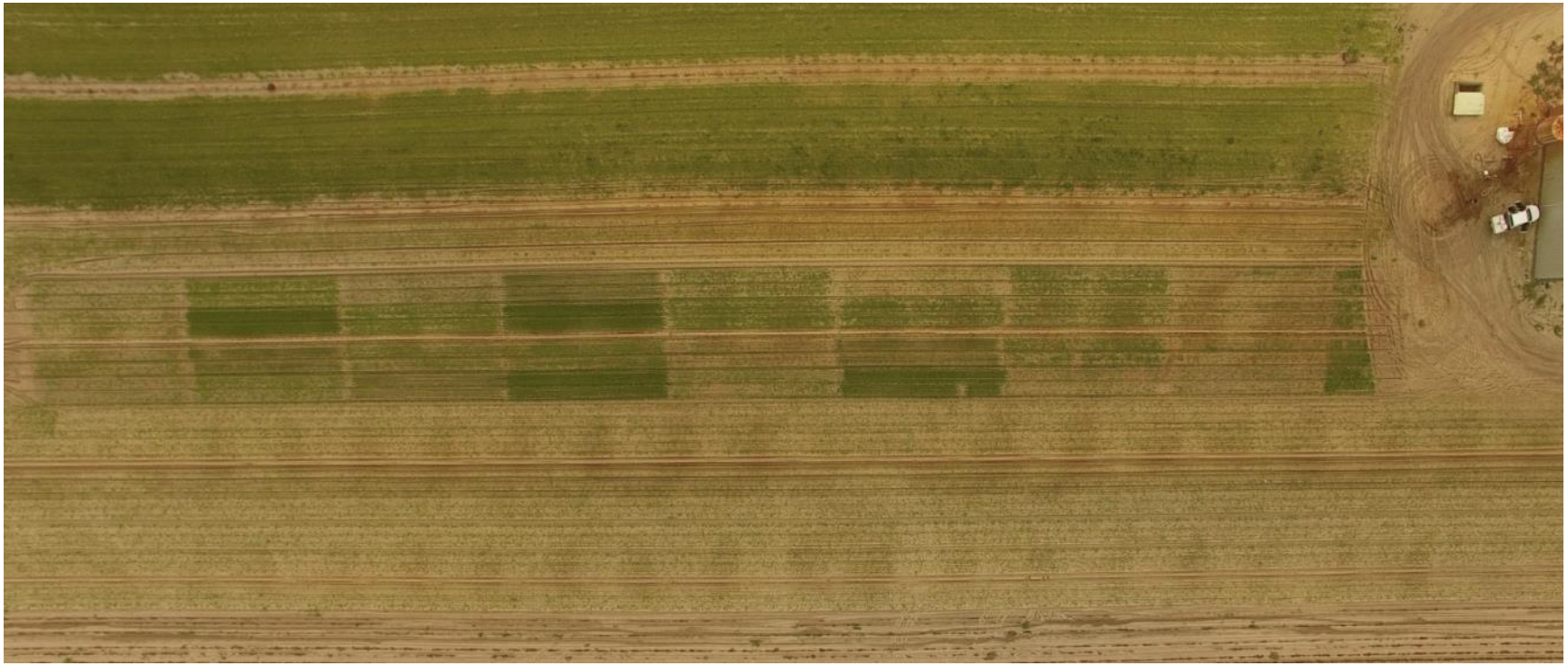
WA Winter cover crops trial



WA Winter cover crops trial

Video

Winter cover cropping for weed management

Winter cover cropping for weed management

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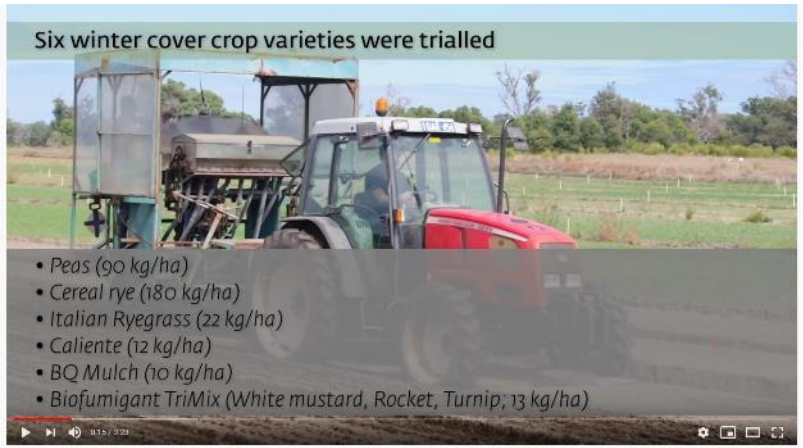
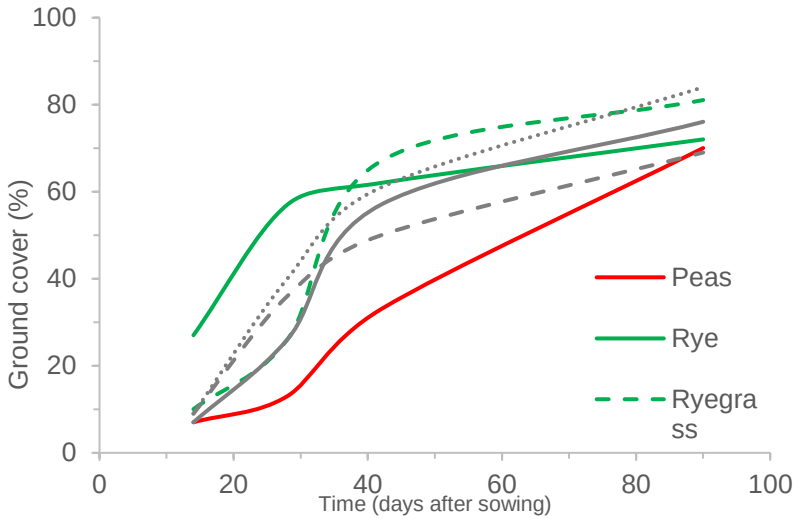


VG15070 Cover crop trial, Myalup Western Australia, April 2018 – Preliminary Results

WA Winter cover crops trial



Cover Crop	Weeds density (plants/sqm)	Weeds Biomass (grams/sqm)
Peas	13.5	17.7
Ryecorn	7.8	0.4
Ryegrass	10.5	3.1
Caliente	15.5	2.7
BQ Mulch	18.5	2.6
TriMix	14.5	2.5

Lesson 1. Successful weed suppression was a cover crop that established quickly and had quick canopy closure e.g. ryecorn (cereal rye)

Lesson 2. Good seed bank management can be a cover crop that gets up gradually up but with canopy closure that excludes light and smothers weeds before they set seed – like a false seed bed!

Lesson 3. Cover crop biomass is good but good canopy closure is key! Too stalky can let light in and allow weeds to persist!

Lesson 4. Support good establishment - treat you cover crop like any crop rotation.

WA Winter cover crops trial, agronomist Grant's insights

Cereal rye

- Rapid germination and early establishment, high vigour, effective at out-competing weeds in the cool season.
- Weeds still present but usually fairly small and therefore less likely to be setting seed.

Ryegrass

- Less early vigour than cereal rye. Some weeds may get above the crop canopy and set seed.
- Forms a thick canopy later in life.
- *Perhaps better suited to the cooler conditions of south-east Australia (Tas/Vic).*

Biofumigants

- Slower early establishment.
- Will form a good canopy later if sown at a suitably high rate.
- Offer the added biofumigant benefit to crops.

In WA, it may be possible to grow a winter cover crop largely with rain – but some irrigation still likely to be required to ensure vigour is maximised. Cover cropping with more water-hungry varieties may not be suited to vegetable farms where water availability is a major limiting factor.

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Tasmania Winter Cover Crop Long Term Trial (10+ years)

Tasmania Winter Cover Crop Long Term Trial (10+ years)

Cover Crop	Weeds Density 48DAS (plants per sqm)	Weeds Density 48DAS (plants per hectare)	Weeds Density 145DAS (plants per sqm)	Weeds Density 145DAS (plants per hectare)
Fallow (weeds)	87.3	872,500	22.3	222,500
Italian Ryegrass	236.5	2,365,000	189.8	1,897,500
Caliente (mustard)	212.0	2,120,000	262.3	2,622,500

Cover Crop	Weeds Biomass N/A (grams per sqm)	Ground Cover 20DAS (%)	34DAS (%)	48DAS (%)	145DAS (%)
Fallow (weeds)	12	2	3	11	5
Italian Ryegrass	24	2	12	21	100
Caliente (mustard)	48	4	19	48	100

Cover Crop	Chickweed (plants per sqm)	Shepherds purse (plants per sqm)	Wild radish (plants per sqm)	Blackberry Nighshade (plants per sqm)
Fallow (weeds)	3.8	2	0.8	9
Italian Ryegrass	166.8	20	0.8	0
Caliente (mustard)	259.0	1	0.3	0

Lesson 1. Chickweed in high numbers, followed by Shepherds Purse, but not really battles worth fighting as they're weak competitors. Wild radish is more of a problem.

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Lesson 2. Above ground patterns = Below ground seed bank

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Lesson 3. Ryegrass was slow to establish but smothered most weeds that germinated, particularly chickweed.

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Lesson 4. Stalky Caliente allowed light penetration and more weeds to persist and go to seed.

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Lesson 5. Caliente – the most weeds, but the least of the one that really mattered.

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Lesson 6. Herbicide fallow for major weed incurrence.

Lesson 7. Potential herbicide resistance of wild radish.

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NSW Summer cover crops trial

NSW Summer cover crops trial

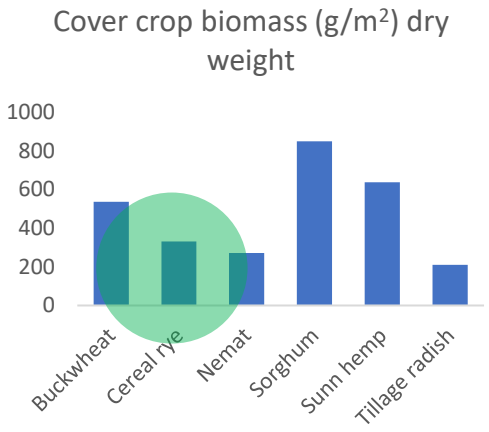
Video

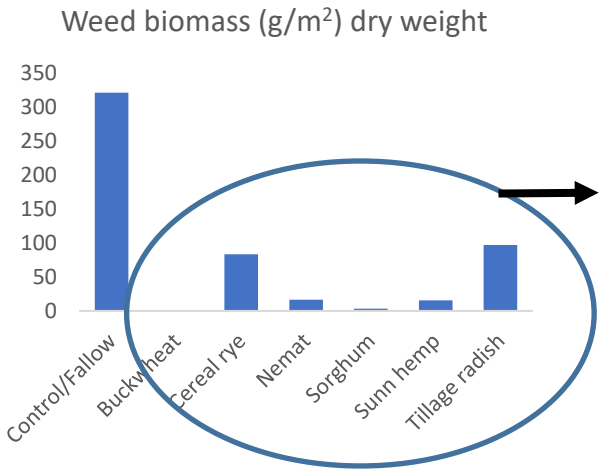
Summer cover cropping for weed management. Part 1: practical perspectives

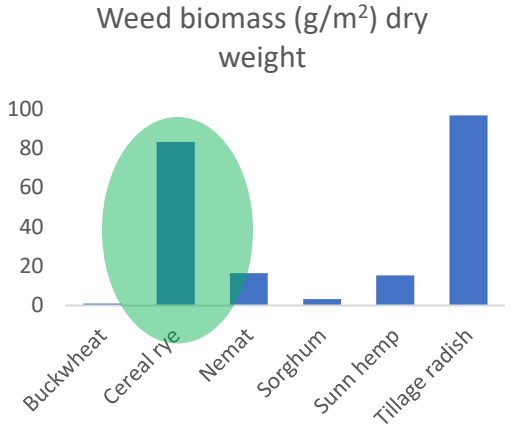
Video

Summer cover cropping for weed management. Part 2: delivering information to industry

NSW Summer cover crops trial



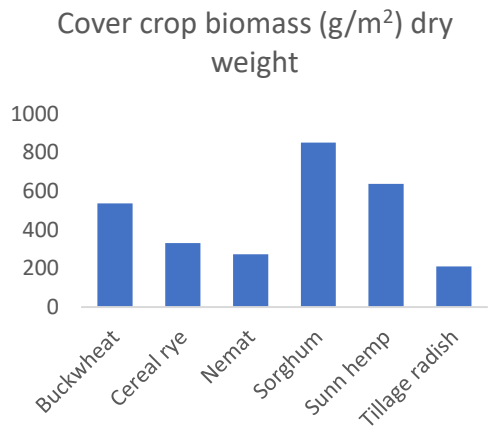


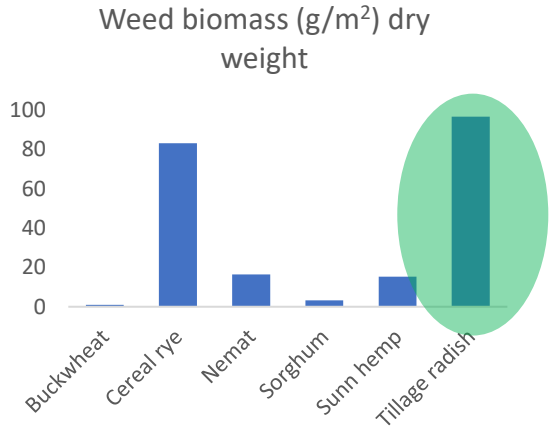


Lesson 1. Plant cover crops to suit the season e.g. ryecorn (cereal rye) was a winter cover crop. It performed okay in terms of biomass out of season, but didn't perform as well as the summer cover crops for weed biomass.

Buckwheat is also a cooler season crop, but it grew and reached 100% canopy cover before all other crops, and performed extremely well at outcompeting weeds. It just shot much earlier (@ 4 wks) in this warm season than it would in a cool season.

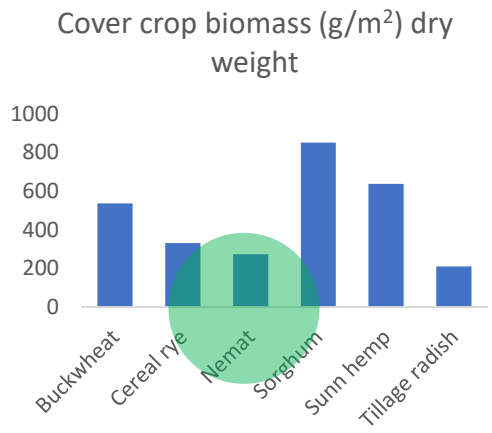
NSW Summer cover crops trial

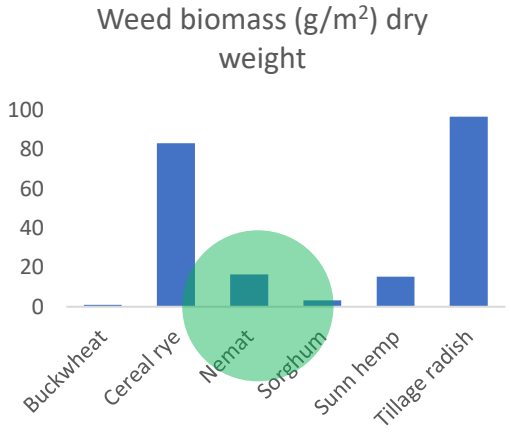




Lesson 2. The importance of the sowing rate e.g. tillage radish (@ 6 kg/ha) was very slow to reach full canopy closure. Weeds that survived were able to grow quite big, so despite a low weed density, it recorded the highest weed biomass. A higher sowing rate would have meant much quicker canopy closure and light exclusion for weeds. The sowing rate was therefore increased in the second season.

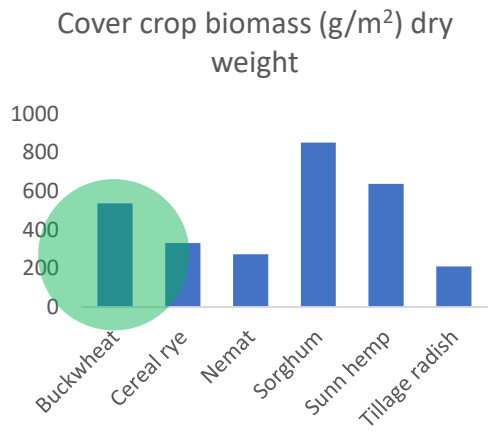
NSW Summer cover crops trial

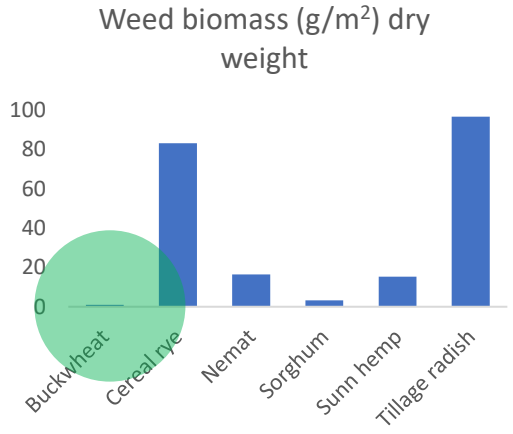




Lesson 3. A low cover crop biomass can still be effective at weed suppression e.g. nemat. Although a small plant, it's leaf morphology meant it shaded out weeds. Think also of the other benefits e.g. nematode suppression, quick to breakdown and minimum till required to prepare for next cash crop (e.g. vs sorghum)

NSW Summer cover crops trial

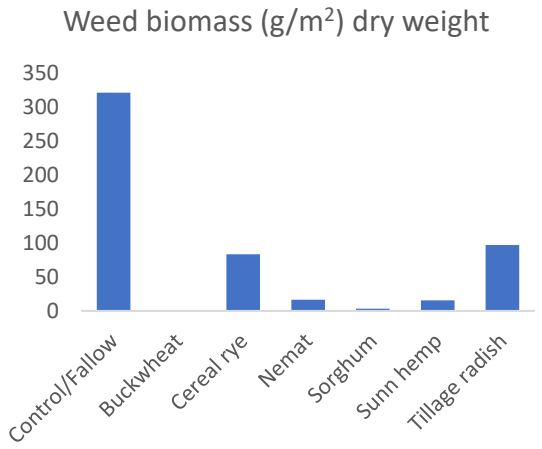




Lesson 4. Terminate cover crops before they themselves set seed and their seeds become part of the 'weed' seed bank e.g. the buckwheat shot and starting seeding at 4 weeks. This could actually work well for a short rotation, and it was very effective at outcompeting weeds. It's soft leaf and stalk also mean it's another cover crop to quickly break down.

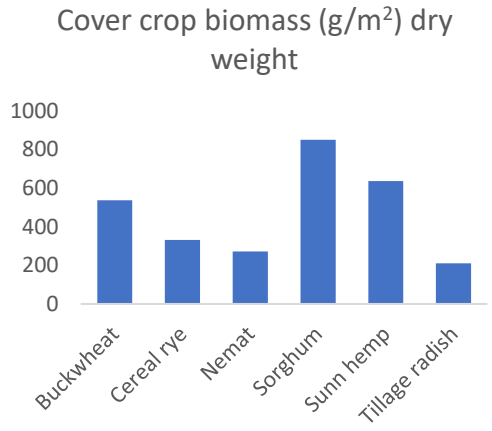
Timing is so important here though. The buckwheat was terminated late after seeding. This meant high numbers of buckwheat seeds in the soil seed bank, and so buckwheat in the following lettuce crop. This could also mean a longer term problem.

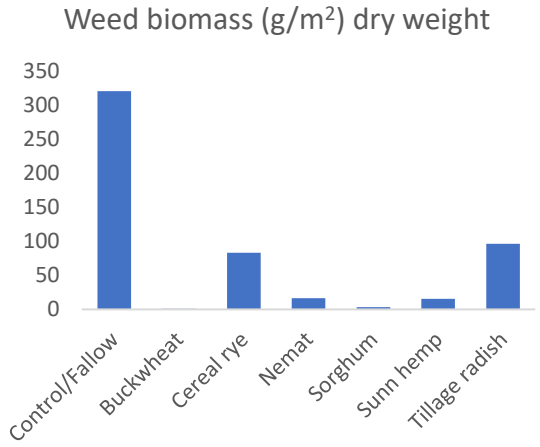
NSW Summer cover crops trial



Lesson 5. All cover crops performed better than a bare unmanaged fallow!

NSW Summer cover crops trial





Lesson 6. Know your problems weeds. Apple of peru was vigorous, and grew like a successful cover crop in the bare fallow.
The out of season cereal rye and low sowing rate of the tillage radish meant they struggled to compete. The right cover crop selection, e.g. sorghum, worked well to outcompete it.

NSW Summer cover crops trial, grower Mario's insights

Sorghum: Mario's favourite.

- Relatively cheap to grow and can use standard seeding equipment.
- Produces very high biomass – suppresses weeds through vigour and canopy.
- Post-termination break-down will take longer due to high biomass & woody stems.

Nemat

- Establishes very quickly and competes well with weeds.
- Breaks down quickly when incorporated.
- May carry disease over in a brassica rotation.

Tillage radish

- Sow at a high enough rate to ensure effective competitiveness and quick canopy cover.
- Relatively slow to establish but forms a good canopy.
- Breaks down quickly when incorporated.

Cereal rye

- Did not perform as well in warm summer climate of Sydney Basin: did not form good canopy.
- Likely more suited to cool season.

Buckwheat

- Rapid growing and produced high biomass.
- Went to seed far too quickly – becomes a weed problem itself.
- Likely more suited to cool season.

University of New England

Qld Summer cover crops trial

Qld Summer cover crops trial

Lesson 1. The most weeds occurred under the stalky cover crop that allowed light penetration to the soil surface. If sown at a higher rate, and/or terminated before seed set this is okay for long term seed bank reduction.

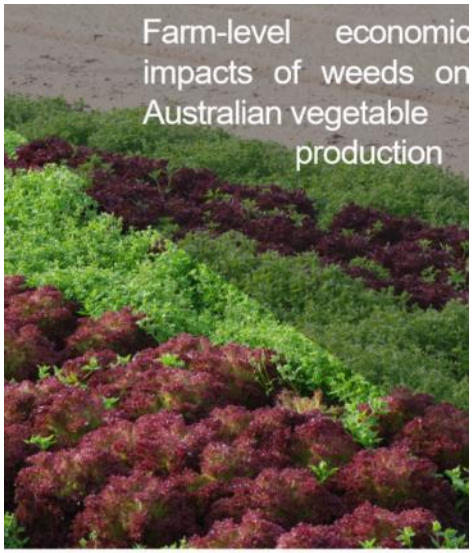
Lesson 2. The very slow to establish black jack radish had the most weeds early on, BUT, the least weeds (= 0!) by the end. Including during the pigweed and fat hen incursion during drought conditions. This is equivalent to a false seed bed. Weed seeds germinated but died due to lack of light under the thick, broad leaved radish. A very effective strategy for long-term weed seed bank depletion.

Lesson 3. The importance of a well supported and well timed crop. In the second cover crop rotation, Gatton was in drought. Quality water was limited, and temperatures extreme. The cover crops ended up being a field of pigweed, amaranth and fat hen.

Other key lessons shared by our trial growers

- Winter cover crops can help with winter weeds, and vice versa for summer. A cover crop rotation targeted at reducing the weed seed bank of your worst weed problem is a strategic option.
- Choose a variety suited to crop rotation e.g. brassica biofumigant (e.g. nemat) not suited to a brassica cash crop rotation due to disease carryover risk.
- Support establishment (H2O, fertilise) as you would for any crop rotation. Cover crops require water and fertiliser to maximise their performance and benefits in weed suppression – you need to be happy and able to dedicate resources to them, and can't just 'sow and forget'.
- The benefits in using grass cover crops: avoid disease carryover in brassicas; selective herbicide options for broadleaf weeds.
- A non selective can be used to terminate the cover crop - this also kills the weeds (like a stale seed bed!)
- Terminate cover crops before weeds set seed!
- Understand your weeds, download at: www.une.edu.au/iwmvegetables

Farm-level Economics Report



- Potatoes grown in a three-year rotation, followed by fallow period, ryegrass (5kg/ha) for soil health reasons and sown higher than the standard rate in order to more effectively smother weeds (cut three times for silage), then Caliente; *Brassica juncea* and Nemat; *Eruca sativa* seed mix is sown.
- The biofumigant cover crop is well supported to ensure a vigorous crop, providing weeds with minimal opportunities to compete.
- At flowering, the biofumigant cover crop is terminated (high-speed mulcher) and quickly incorporated (high-speed disc plough). This is intended to generate a biofumigant effect in the soil that helps to kill weed seed.
- The grower observed that the overall impact of the biofumigant cover crop is to reduce weeds in the potato crop by 85 per cent compared to a fallow.
- The grower observed that the previous herbicide regime 'knocks back' the potato crop so that 3-4 weeks of crop growth was lost = 3 t/ha loss in pack-out yield. This yield loss is avoided when using the biofumigant cover crop and less herbicides, thus increasing yield and revenue.
- $ After introducing the biofumigant cover crop, whole farm operating profit increased $1,917 per hectare of potatoes grown!

Integrated Weed Management

Case study in **Sydney Basin** was undertaken April 2020 – August 2020.

- ✓ Herbicides (preplant)
- ✓ Cover Crops

  Ryecorn vs Ryegrass vs Buckwheat

  Buckwheat + Ryegrass

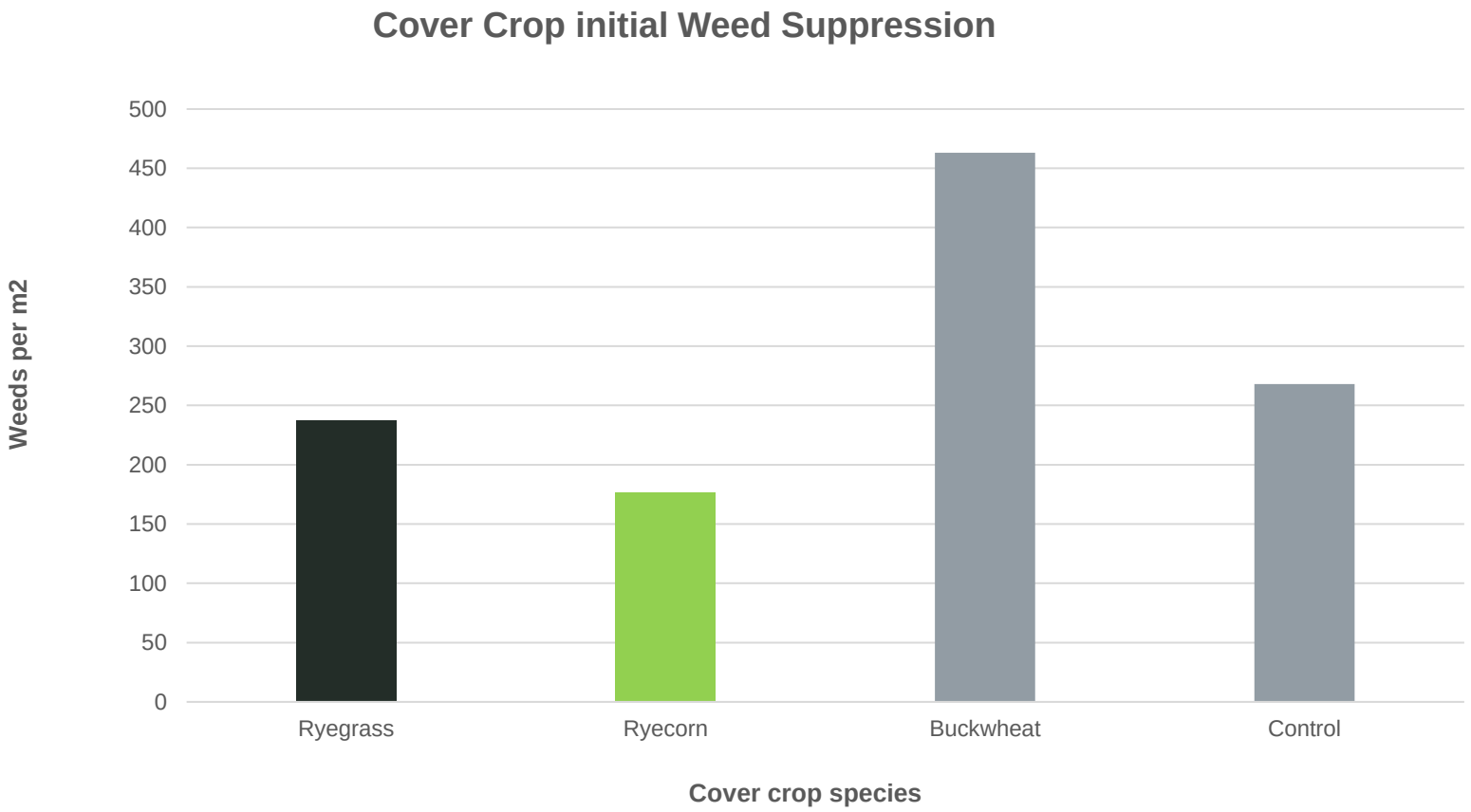
  Ryecorn + Ryegrass
- ✓ Handweeding **(x 15)**
- ✓ Mowing

27 May 2020

Buckwheat 30 DAP

Ryegrass 30 DAP

Sydney Basin inter-row Cover Crops



Cover Crop Objectives

Integrated Crop Protection
PROTECTING CROPS
SoilWealth
NURTURING CROPS

Ryecorn 66 DAP

Ryegrass 66 DAP

Ryegrass the standout 23 Sept 2020

Ryegrass

- Loved Sydney autumn & winter weather
- Prostrate *and* outcompetes most weeds
- Handles mowing, extreme weather & foot traffic

Ryecorn

- Fewer tillers, erect growth to 1.5 metres tall
- Did NOT survive mowing + constant foot traffic
- Hosted more aphids

Cover crops for Australian Vegetable Growers

- Poster in Autumn Vegetables Australia magazine
- Summary of 48 cover crops with weed suppression included

INTRODUCTION

This table provides a starting point for helping you choose a cover crop for your farm. Adapt the information to suit your farming operations, climate and cover crop objective. Also look for local guidance on suitable varieties for your conditions.

SPECIES

The cover crops are grouped into 1) Cereals & Grasses, 2) Legumes, and 3) Broadleaves. In choosing your cover crop you should also consider your crop rotation to minimise potential pest and disease issues. Use the **Cover Crops and Soilborne Disease** table for additional guidance.

The most common cover crop species are listed at the top of the groupings, with some less used options at the bottom.

RATINGS

The table provides the user with a summary of cover crops benefits and tolerance of growing conditions, relative to each other. Varietal differences and growth stage at the time of any environmental stress will influence the relative rating. Specific local information should be sought on varieties. This is particularly important for biofumigants.

A 5-star rating system is used in the table:

***** EXCELLENT
**** VERY GOOD
*** GOOD
** FAIR
* POOR

COOL AND WARM SEASONS

The cover crop groups are divided into cool and warm season. Use the map to help guide your choice of cover crops for your season. Growing cover crops in their optimal time of year will typically maximise the benefits and reduce potential insect and disease issues.

COOL SEASON

Cool season cover crops can be grown in most areas over winter. Germination and early growth will be affected by soil temperatures in autumn. Early sowings will establish quicker and lower sowing rates can be used. As the soil temperature declines, increase sowing rates to get good establishment and cover.

WARM SEASON

In the warm to hot summer areas (see map), warm season cover crops can be grown to produce high levels of biomass. Look for greater heat tolerance for hot areas in the north and inland regions.

In the mild/warm summer areas, warm season cover crops will grow, once the minimum soil temperature is reached, but will produce biomass at the bottom end of the range. Most cool season cover crops will produce more biomass than warm season cover crops during the summer in this area. Look for cool season cover crops with greater heat tolerance for growing over summer in these areas. Also, choose cover crops which aren't affected by daylength. Daylength sensitive cover crops, e.g. radish, cereal rye, will bolt and produce less biomass if sown in early summer.

1. WHAT BENEFITS?

PROTECT SOIL AND ADD BIOMASS

A key role of cover crops is to protect the soil from water and wind erosion, as well as adding biomass to help maintain and build soil organic matter. Only the above ground biomass is considered in this table - add another 20-25% for root biomass. Active growing roots also add microbe stimulating exudates, especially in the early stages of growth.

The biomass range (t/ha above ground dry weight) will be influenced by conditions and management. Low biomass will be produced when a cover crop is stressed due to a poor match to growing conditions, is not well supplied with water and nutrients or sown at low rates. Early terminated cover crops will also result in low biomass. Use the **Cover Crops and Termination** table for guidance on cover crop termination methods and impact on biomass quantity and quality.

SUPPRESS WEEDS

The most successful cover crops for weed suppression typically establish quickly and/or form a dense canopy. The rating assumes that the cover crop is sown in the right season and is well supplied with fertiliser and water to ensure a competitive stand.

Cover crops that germinate and grow quickly tend to be more effective in suppressing early-germinating weeds. Canopy density can be influenced by sowing rate, and fertiliser and water supply. Dense canopies allow less light to penetrate to the soil surface, reducing the number of weeds that germinate, grow and set seed.

All cover crop choices will benefit from effective weed management in the period leading up to sowing, by reducing the impact of early weed germination and competition during cover crop establishment. Use the **Cover Crops and Herbicides** table for guidance on herbicides.

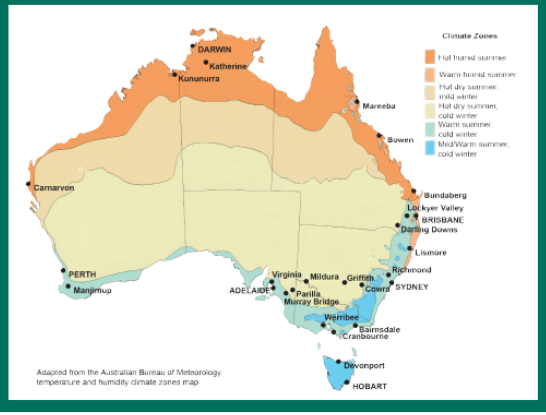
Use the **Integrated Weed Management for the Australian Vegetable Industry** manual, due for publication in 2021, for detailed guidance.

ADD NITROGEN

Legume cover crops can add up to 150-200 kg/ha of nitrogen when grown well with the right rhizobium.

COVER CROPS

FOR AUSTRALIAN VEGETABLE GROWERS



Adapted from the Australian Bureau of Meteorology temperature and humidity climate zones map

The ratings for the legumes are based on above ground biomass produced and assume a nitrogen fixation rate of 20 kg nitrogen per tonne of biomass.

* indicates that the cover crop does not add nitrogen.

RECOVER NUTRIENTS

Cover crops can play an important role in recovering and storing nutrients remaining in the soil after a vegetable crop. The ratings summarise a cover crop's ability to scavenge for nutrients in the soil and to access nutrients below the root zone of vegetable crops through deep rooting. The nutrients recovered and stored in the cover crop biomass are released to benefit the following vegetable crops and help reduce the off-farm environmental impacts.

BIOFUMIGANTS

Biofumigation is the use of specialised cover crops which are grown, mulched and incorporated into the soil prior to cropping. High biomass can provide the traditional benefits of cover crops and, if done right, naturally occurring compounds from the biofumigant plants can suppress soilborne pests, diseases and weeds. The table only summarises the biofumigant cover crops at the species level. Varieties vary considerably. For performance of biofumigant varieties see the **Guide to Brassica Biofumigant Cover Crops: Managing soilborne diseases in vegetable production systems.**

* indicates no biofumigant activity.

2. GROWTH TOLERANCES

Choosing cover crops well suited to the conditions is important, but remember to get the most out of your cover crops your need to treat them like a crop by sowing at the right time, avoiding main pest and disease periods, and giving them adequate nutrition and water.

The table summarises the relative tolerances of the cover crops to heat, drought, waterlogging and frost. Use these ratings to identify cover crops which will cope with the growing conditions expected in your region.

3. SOIL CONDITIONS

Use the soil conditions to make sure the cover crop is suited to your soil's pH. The minimum soil temperature for germination is provided and for best results the temperature should be rising for early sowing of warm season cover crops.

4. SOWING

Practical information on sowing cover crops is summarised.

Possible sowing rates (kg/ha) are provided as a guide. The lower rate would be suitable for drilled cover crops at the optimum sowing time. Use higher rates when broadcasting, sowing late in the season, or for improved weed suppression.

Seed size and sowing depth information is provided to help match with sowing machinery.

If the legume is not regularly grown, then adding the right rhizobium inoculant is very important.

The specific rhizobium inoculant for each legume is provided. For the best result, coat seed and sow on same day.

5. ESTABLISHMENT

The establishment time provides a ranking of the relative speed to achieve ground cover. This will be important for outcompeting weeds and providing protection against wind and water erosion. Sowing rates and soil temperatures will have a big influence on establishment time.

Root depth is important in stabilising subsoil structure, e.g. after deep ripping, scavenging for nutrients below crop roots, and for drought tolerance. Three classes for root depth are used: Shallow – majority of roots 0-50 cm; Medium – majority of roots 0-100cm; and Deep – roots can grow deeper than 100cm.

COVER CROPS FOR VEGETABLE GROWERS

Cover Crop Quick Reference table for picking a cover crop.

Pick your season, your main purpose (1), and expected growth (2) and soil conditions (3). The suggested sowing practices are provided in 4, with 5 providing an indication of establishment.

More information on how to use the Quick Reference table is on the back. For other cover crop resources **visit www.soilwealth.com.au**

SPECIES	1. WHAT BENEFITS?					2. GROWTH TOLERANCES				3. SOIL CONDITIONS		4. SOWING				5. ESTABLISHMENT	
	PROTECT SOIL & ADD BIOMASS (t/ha)	SUPPRESS WEEDS	ADD NITROGEN	RECOVER NUTRIENTS	BIOFUMI-GANT	HEAT	DROUGHT	WATER-LOGGING	FROST	pH (water)	LOWEST GERMINATION TEMP (°C)	RATE (kg/ha)	SEED SIZE	DEPTH (cm)	RHIZOBIUM INOCULANT	TIME	ROOTING DEPTH
CEREALS & GRASSES																	
COOL SEASON																	
Cereal rye (*Secale cereale*)	3 - 10	****	*	*****	*	**	***	***	***	4.9 - 7.9	3	60 - 120	M	1 - 3	NA	quick	deep
Oat (*Avena sativa*)	2 - 10	**	*	****	*	**	***	***	***	4.5 - 7.5	8	80 - 110	M	3 - 6	NA	quick	deep
Black/Saia oat (*A. strigosa*)	4 - 10	**	*	****	*	**	***	***	**	4.5 - 7.5	8	50 - 70	S - M	3 - 6	NA	quick	deep
Annual ryegrass (*Lolium multiflorum/rigidum*)	2 - 9	****	*	****	*	*	**	***	***	5.5 - 7.5	13	15 - 20	S	1 - 2	NA	slow	medium
Barley (*Hordeum vulgare*)	2 - 10	***	*	****	*	*	**	**	***	6.0 - 7.9	8	50 - 100	M	3 - 5	NA	quick	deep
Wheat (*Triticum aestivum*)	3 - 8	**	*	****	*	*	**	*	***	5.5 - 7.9	5	60 - 120	M	2 - 4	NA	medium	deep
WARM SEASON																	
Sorghum (*Sorghum bicolor*)	4 - 14	****	*	*****	***	****	***	**	*	>4.8	16	15 - 30	M	3 - 5	NA	medium	deep
Sorghum x Sudan grass (*S. bicolor x S. sudanense*)	4 - 10	****	*	*****	**	*****	*****	***	*	>4.8	18	20 - 30	M	2 - 4	NA	medium	deep
Sudan grass (*Sorghum sudanense*)	4 - 10	****	*	*****	*	****	****	**	*	>4.8	18	15 - 30	M	1 - 2	NA	medium	deep
Millet - French or Proso (*Panicum miliaceum*)	2 - 8	***	*	****	*	*****	***	*	*	4.5 - 9.0	14	8 - 15	S	1 - 2	NA	medium	medium
Millet - Japanese (*Echinochloa esculenta*)	2 - 6	***	*	****	*	****	**	**	*	4.6 - 7.4	15	10 - 30	S	1 - 3	NA	medium	medium
Teff (*Eragrostis tef*)	3 - 8	**	*	***	*	**	****	*****	*	>4.8	18	6 - 12	VS	0.3 - 1	NA	medium	shallow
LEGUMES																	
COOL SEASON																	
Faba bean (*Vicia faba*)	6 - 8	**	*****	**	*	**	**	***	***	6.0 - 7.2	4	100 - 200	L	5 - 8	F	slow	shallow
Vetch, Woollypod "hairy" (*V. villosa*)	4 - 7	**	****	**	*	*	**	**	****	5.0 - 7.5	9	25 - 40	M	2 - 4	E	slow	medium
Vetch, common (*V. sativa*)	2 - 5	**	***	**	*	*	**	**	****	5.0 - 7.5	6	50 - 60	M	1	E	medium	medium
Field pea (*Pisum sativum*)	3 - 8	**	****	**	*	**	**	**	***	6.0 - 7.0	6	80 - 120	M	3 - 7	E or F	medium	shallow
Clover, white (*Trifolium repens*) - perennial	2 - 6	**	****	**	*	***	**	****	**	6.0 - 7.0	5	4 - 12	S	1	B	medium	shallow
Clover, berseem (*T. alexandrinum*)	3 - 7	***	****	**	*	***	**	**	*	7.0 - 7.5	6	10 - 20	S	1	B	medium	shallow
Clover, balansa (*T. michelianum*)	3 - 6	**	****	**	*	*	***	***	***	5.0 - 7.0	6	4 - 8	S	1	C	medium	medium
Clover, crimson (*T. incarnatum*)	3 - 6	**	***	***	*	*	*	*	***	5.5 - 7.0	6	10 - 20	S	1	C	medium	deep
Clover, red (*T. pratense*)	2 - 5	**	***	***	*	**	**	**	**	5.5 - 7.0	5	5 - 10	S	1	B	medium	deep
Lentil (*Lens culinaris*)	2 - 5	*	***	**	*	***	***	*	***	6.0 - 7.5	5	50 - 60	M	5 - 10	F	slow	shallow
Lupin (*Lupinus* spp.)	2 - 8	*	***	***	*	**	***	**	***	4.5 - 7.0	5	70 - 100	M	3 - 5	G or S	slow	medium
Medic (*Medicago* spp.)	1 - 4	*	**	**	*	****	***	**	***	6.0 - 7.5	10	10 - 20	S	1	AL or AM	slow	shallow
Serradella (*Ornithopus* spp.)	3 - 8	*	****	**	*	***	**	**	**	4.5 - 7.0	5	2 - 5	S		S or G	slow	medium
Biserrula (*Biserrula pelecinus*)	3 - 8	***	****	***	*	**	****	*	***	4.0 - 7.5	5	10 - 20	M	3 - 5	WSM1497	medium	deep
WARM SEASON																	
Lablab (*Lablab purpureus*)	4 - 12	***	*****	***	*	*****	*****	*	*	5.0 - 7.5	18	20 - 40	L	4 - 6	J	medium	deep
Soybean (*Glycine max*)	2 - 8	*	****	**	*	***	***	***	*	5.5 - 7.5	15	40 - 60	M	2 - 5	H	medium	medium
Cowpea (*Vigna unguiculata*)	2 - 6	***	***	**	*	*****	****	*	*	4.5 - 6.5	18	35 - 90	M	3 - 6	I	medium	deep
Mung bean (*V. radiata*)	1 - 6	**	***	**	*	*****	*****	**	*	5.5 - 7.5	18	20 - 30	M	2 - 4	I	medium	medium
Sunn hemp (*Crotalaria juncea*)	4 - 8	****	****	***	*	*****	****	*	*	6.0 - 7.5	14	10 - 20	M	.5 - 3	I	medium	medium
Lucerne (*Medicago sativa*) - perennial	4 - 10	**	*****	***	*	*****	*****	***	***	6.5 - 8.0	4	15 - 25	S	1	AL	slow	deep
Sulla (*Hedysarum coronarium*) - perennial	3 - 10	*	****	***	*	**	***	**	**	6.5 - 8.5	15	6 - 12	S	1 - 2	WSM1592	slow	deep
BROADLEAF (NON-LEGUME)																	
COOL SEASON																	
Fodder mustard (*Brassica napus*)	8 - 16	***	*	****	***	***	**	***	***	6.0 - 7.5	6	6 - 12	S	1 - 2	NA	medium	medium
Indian mustard (*Brassica juncea*)	4 - 15	****	*	****	*****	***	**	**	***	6.0 - 7.5	5	6 - 14	S	1 - 2	NA	medium	medium
Oilseed radish (*Raphanus sativus var. oleiformis*)	5 - 12	***	*	*****	****	***	**	**	***	6.0 - 7.5	7	9 - 15	M	1 - 2	NA	medium	deep
Turnip (*Brassica rapa*)	2 - 6	***	*	***	***	***	**	**	**	6.0 - 7.5	5	5 - 8	S	1 - 2	NA	medium	deep
White mustard (*Sinapis alba*)	4 - 12	**	*	****	***	***	**	**	**	6.0 - 7.5	4	10 - 20	S	1 - 2	NA	medium	medium
Rocket (*Eruca sativa*)	2 - 8	****	*	***	***	***	***	**	***	6.0 - 7.5	6	8 - 16	S	1 - 2	NA	medium	medium
Chicory (*Cichorium intybus*) - perennial	3 - 6	**	*	****	*	***	***	*	****	5.5 - 7.0	12	4 - 7	S	1 - 3	NA	medium	deep
Linseed (*Linoideae & Hugonioideae*)	2 - 5	*	*	**	*	**	***	**	***	6.0 - 7.5	9	30 - 50	S	1 - 3	NA	slow	medium
Phacelia (*Phacelia tanacetifolia*)	3 - 6	***	*	***	*	**	***	*	***	6.5 - 8.5	10	8 - 10	S	1	NA	slow	medium
WARM SEASON																	
Buckwheat (*Fagopyrum esculentum*)	2 - 6	****	*	****	*	***	*	*	**	5.0 - 7.0	10	30 - 70	M	1 - 2	NA	quick	shallow
Tillage Radish (*Raphanus sativus*)	6 - 12	****	*	*****	***	****	**	**	***	6.0 - 7.5	7	3 - 10	M	1 - 3	NA	medium	deep
Ethiopian mustard (*Brassica carinata*)	6 - 14	***	*	****	*****	****	***	**	**	5.5 - 7.5	7	5 - 15	S	1 - 2	NA	medium	medium
Safflower (*Carthamus tinctorius*)	3 - 8	*	*	*****	*	*****	****	*	**	6.0 - 8.0	5	15 - 25	M	2 - 3	NA	slow	deep
Sunflower (*Heliantus annuus*)	3 - 8	*	*	***	*	****	***	*	**	5.5 - 8.0	10	5 - 10	L	2 - 5	NA	medium	medium
Marigold (*Tagetes* spp.)	1 - 3	***	*	**	*	****	**	*	*	6.0 - 7.5	18	1 - 2	M	2	NA	medium	shallow

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Updates and Resources

www.une.edu.au/iwmvegetables

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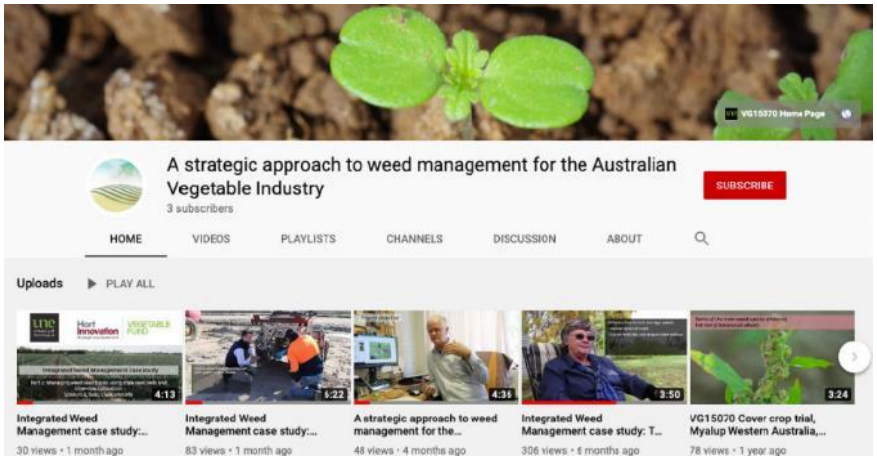

Thanks

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