This document contains descriptions of 40 fallow-period cover crop species that are used in organic cropping systems. It is a complementary resource associated with the technical guide *Choosing and managing cover crops in organic agricultural systems*, which was published in July 2012. The guide is available for download on the ITAB website: http://www.itab.asso.fr/publications/Cahier%20Couverts_ENG_2018.pdf.

These species descriptions are the result of literature reviews and discussions among the members of a national working group focused on cover crops in organic cropping systems. The working group was managed by ITAB and the national network of chambers of agriculture, which comprises agricultural advisors, coordinators, and other experts in organic agriculture.

**Sections:**

Method for choosing cover crops (a reminder)

Composing a mixture and some examples (a reminder)

List of species descriptions and legend

Species descriptions

Additional references

**Choosing a cover crop species**

**Step 1: Defining constraints**

I. Crop rotation/sequence

II. Sowing period

III. Fallow-period duration

IV. Soil type

**Step 2: Ranking the objectives** (defining one or more management goals)

- Maintenance of soil organic matter
- Nitrogen release to the following cash crop
- Weed control
- Forage production
- Improvement of soil structure
- Pest control

**Final choice**

This process will lead to a selection of species that are suited to a given situation. The farmer can then choose whether to utilise a single cover crop species or a species mixture. When making the final choice, other factors to consider include seed cost and seed availability (on the commercial market or as farm-saved seeds).

**Step 3: Defining sowing/termination dates and methods**
COMPOSING A MIXTURE

(approach recommended by the Meurthe and Moselle Chamber of Agriculture)

First, for cover crops to develop properly, it is necessary to choose species whose characteristics match with planned sowing and termination dates and methods. Second, it is also important to keep in mind the identity of the following cash crop and potential threats to plant health, even if risks are lower when mixtures are used instead of single species. Third, even if it is theoretically possible to mix seeds of all sizes, different seeds may have different sowing requirements. For example, planting depth may vary. Consequently, farmers may have to make two passes with the seed drill: once to sow seeds with deeper planting depths and once to sow seeds with shallower planting depths. This approach is used to plant mixtures of faba bean and mustard, for example.

All mixture types can lead to successful cover establishment and biomass production. However, following a few guidelines can ensure that farmers obtain optimal results:

- Combine plants with different morphologies (e.g., slender, bushy, low-lying, climbing)
- Use species with diverse root systems
- Use species that flower rapidly in the autumn to provide pollen and nectar to beneficial insects at a time of year when such resources are rare
- Adjust the sowing density of each species to limit overrepresentation by any one plant or excessive competition, both of which could prevent optimal, balanced cover crop growth

If the goal is to improve soil structure, it is important to combine species with different root systems. If the goal is to retain nitrogen over the winter so that it can be passed along to the following cash crop, it is helpful to use mixtures of legumes and grasses or of legumes and brassicas. In both cases, cover, and thus weed suppression, can be maximised.

CALCULATING SOWING DENSITY

To calculate sowing rates for species mixtures, you must multiply the monoculture sowing rate for each species by the proportion desired in the mixture. In some cases, the sowing rate can be increased by 20% to ensure proper cover development.

Here is an example calculation for a mixture of spring faba bean (50%), blue tansy (25%), and radish (25%):

- **faba bean** = 100 kg * 0.5 = 50 kg/ha
- **blue tansy** = 12 kg * 0.25 = 3 kg/ha
- **radish** = 15 kg * 0.25 = 3.8 kg/ha

There are no established types of mixtures; many combinations are possible. The ultimate goal is to maximise the complementary benefits of different species.

When calculating sowing rates, it is crucial to take regulatory standards into account. The proportion of legumes allowed in mixtures varies by department. Farmers must check departmental regulations to verify maximum allowable proportions.

A FEW EXAMPLES

- **buckwheat** (40 kg/ha) + blue tansy (8 kg/ha) or mustard (8 kg/ha)
- **blue tansy** (3 kg/ha) + rye (22 kg/ha)
- **winter oat** (60 kg/ha) + crimson clover (10 kg) or forage pea (100–120 kg/ha)
- **spring oat** (60 kg/ha) + forage pea (50 kg/ha), black medic (8 kg/ha), or white clover (5 kg/ha)
- **Italian ryegrass** (8–10 kg/ha) + rye (15 kg/ha) or crimson clover (12–18 kg/ha)
- **vetch** (15 kg/ha) + rye (10 kg/ha)

THE EXPERIENCE OF A FARMER IN AQUITAINE (DEPARTMENT OF LOT AND GARONNE)

To cover the soil and maintain soil organic matter after a faba bean/wheat sequence, Philippe Guichard stubble ploughed his field using a disc harrow and then broadcast sowed the following mixture:

- **faba bean** (200 kg/ha) + daikon (15 kg/ha)
- **sunflower** (35 kg/ha)
The following pages provide descriptions of the major fallow-period cover crop species used in organic cropping systems. The species are organised by taxonomic family, and their general characteristics are described (e.g., ability to capture and release nitrogen, biomass production, placement in the rotation). Recommendations related to species establishment and termination are provided, making easier to select and grow the cover crop of choice, whether alone or as part of a mixture.

### Species Descriptions

#### Legumes
- **Faba bean** p. 4/5
- **Fenugreek** p. 6
- **Grass pea** p. 7
- **Forage lentil** p. 8/9
- **Bird's-foot trefoil** p. 10
- **Yellow lupin** p. 11
- **Lucerne** p. 12
- **Water medic** p. 13/14
- **Sweet clover** p. 15/16
- **Black medic** p. 17/18
- **Field pea** p. 21/20
- **Forage pea** p. 21/22
- **Sweetvetch** p. 23
- **White clover** p. 24/25
- **Berseem clover** p. 26/27
- **Crimson clover** p. 28
- **Red clover** p. 29/30
- **Persian clover** p. 31
- **Vetch** p. 32/33
- **Hairy vetch** p. 34

#### Grasses
- **Spring oat** p. 35
- **Winter oat** p. 36/37
- **Black oat** p. 38/39
- **Foxtail millet** p. 40/41
- **Proso millet** p. 42
- **Italian ryegrass** p. 43/44
- **Italian ryegrass** (alternative) p. 45
- **Rye** p. 46/47
- **Sudan grass** p. 48/49

#### Composites
- **Nyger** p. 64/65
- **Sunflower** p. 66/67

#### Waterleaves
- **Blue tansy** p. 68/69

#### Buckwheat family
- **Buckwheat** p. 70/71

#### Brassicas
- **Camelina** p. 51/52
- **Winter rapeseed** p. 53
- **Winter forage rapeseed** p. 54/55
- **White mustard** p. 56/57
- **Brown mustard** p. 58/59
- **Winter turnip rape** p. 60/61
- **Forage radish** p. 62/63

#### Linseeds
- **Linseed** p. 72/73

Use care with winter crops (e.g., rapeseed, radish, turnip rape, wheat, barley): they display varying degrees of cold tolerance.

### Legend:

This image indicates that the species produces NECTAR/POLLEN and thus attracts both domesticated bees and wild pollinators.

**Seed costs*** are calculated in €/ha, which are indicated using the following scale:

- ○○○○○ < 30 €/ha
- ○○○○ 30–60 €/ha
- ○○○○ 60–90 €/ha
- ○○○○○ 90–120 €/ha
- ○○○○○○ > 120 €/ha

* Nitrogen capture and release: low (0–20 u), intermediate (20–40 u), high (40–60 u)

* Fallow-period duration: short (< 80 days), intermediate (80 < days < 120), long (> 120 days)

*Cost of purchased seeds. Seed costs can be reduced by employing farm-saved seeds.

### Try Out Some Other Species That Can Be Used As Cover Crops:

- soybean, serradella, spinach, hemp, corn spurry, orchard grass, lupin, bromegrass, meadow fescue, mouse-ear hawkweed, English ryegrass, comfrey, rattlœpod, tansies, quinoa, and many others...
Faba bean

Vicia faba

General characteristics

Advantages
- Strong growth
- No risk of bolting
- Easy to terminate
- Fixes large amounts of atmospheric nitrogen

Disadvantages
- Cannot serve as forage (except as part of immature mixed cover)
- Successful seedling growth requires high sowing rate (susceptible to weed competition during early development)
- Large seeds—tricky to sow and compose mixtures

Weed control: limited (erect plants provide little cover)

Growth features

Germination: slow to intermediate
Growth rate: intermediate to high
Fallow-period duration: intermediate to long (2–6 months)

Soil

Type: silty, clayey calcareous soils
Preparation: no specific requirements
Effect on structure: very positive (intermediate system—taproot and fibrous roots)

Sowing

<table>
<thead>
<tr>
<th>Period</th>
<th>Method</th>
<th>Depth</th>
<th>Rate</th>
<th>Cost (€/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any</td>
<td>Row sowing highly recommended; narrow spacing</td>
<td>3–6 cm</td>
<td>180 kg/ha TKW = 300–600 g</td>
<td>⬤⬤⬤⬤⬤</td>
</tr>
<tr>
<td></td>
<td>Broadcast sowing—cover ground well</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Mixtures: can be used with grains (e.g., sorghum, oat), other legumes (e.g., vetch), or brassicas (e.g., rapeseed)

Termination

Freeze tolerance: Hardy (winter variety) < -15°C
Sensitive (spring variety) ≤ -5°C

Most effective methods
1. Winter killing + crushing/shredding, stubble ploughing
2. Ploughing/tilling

Placement in rotation

Grains, sunflower
Avoid legumes

Faba bean
Avoid legumes, protein crops, and other species susceptible to Sclerotinia diseases

Nitrogen-demanding crops (e.g., maize)

Written by:
Adeline Cadillon (ITAB)
With assistance from:
L. Prieur (CREAB), G. Salitot (Picardie Chamber of Agriculture), M. Mangin (ARVALIS), P. Guichard (farmer), M. Pottier (CORAB), S. Minette (Poitou-Charentes Chamber of Agriculture), J. Champion (Drôme Chamber of Agriculture), J. Bayle (Meurthe and Moselle Chamber of Agriculture), J. Arino (Gers Chamber of Agriculture)
If you use faba bean, your sowing rate needs to be high enough. Establishment can fail if there are too few seeds on the ground. You also need to make sure the seed is buried deep enough. It is easy to incorporate faba bean into mixtures. It is better to use varieties with low TKW values, such as FEVITA®.

It is important to use the roller before sowing. This cover crop is easy to terminate via crushing. You can then sow your maize directly, without preparing the soil.

Faba bean is a hardy plant that produces lots of biomass and generates large amounts of nitrogen. Its sowing rate is rather high (90–100 kg/ha). The cover becomes thick at around 3 weeks to 1 month. Faba bean has a significant impact on soil structure. It is often mixed with either oat or mustard. Because of the large seed size, the logistics of mixtures may be tricky. However, the seeds can be planted separately (e.g., using slug pellet applicators and a centrifugal fertiliser spreader [DP12] on the front and back of the tractor, respectively, and then burying the seeds with a roller or a tine harrow). Faba bean is easy to eliminate: just shred it or crush winter-killed plants.
**Fenugreek**

*Trigonella faenum-graecum*

## General Characteristics

### Advantages
- Can be used as forage (harvest before it bolts) or to produce seeds
- Grown namely in southern France (hot, dry conditions)
- Fixes large amounts of atmospheric nitrogen
- Companion crop

### Disadvantages
- Bolts rapidly
- Intermediate biomass production
- Transmits root rot (*Aphanomyces*)

### Weed Control
- Intermediate to good

### Pest Control
- Poor to intermediate (pungent seeds repel insects)

## Growth Features

<table>
<thead>
<tr>
<th>Biomass</th>
<th>Soil nitrogen capture</th>
<th>Nitrogen release</th>
</tr>
</thead>
<tbody>
<tr>
<td>low to intermediate</td>
<td>intermediate</td>
<td>intermediate to high</td>
</tr>
</tbody>
</table>

*To obtain proper cover development*

## Soil

### Type
- Clayey calcareous soils; does poorly on compacted and anoxic soils

### Preparation
- Fine seedbed

### Effect on Structure
- Positive (taproot)

## Sowing

<table>
<thead>
<tr>
<th>Period</th>
<th>Method</th>
<th>Depth</th>
<th>Rate</th>
<th>Cost (€/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>February to</td>
<td>Well suited to sowing during harvest</td>
<td>2–4 cm</td>
<td>40 kg/haTKW = 25 g</td>
<td>⬤⬤⬤⬤⬤</td>
</tr>
<tr>
<td>October</td>
<td>Broadcast sowing — cover ground well</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Mixtures: good fit with grains (e.g., black oat, sorghum) or other legumes (e.g., vetch, clover)*

## Termination

**Freeze tolerance:**
- Sensitive
- ≤ -2 to -8°C

Sensitivity depends on cover development stage

### Most Effective Methods
1. Shredding/crushing (necessary if cover is allowed to develop)
2. Ploughing/tilling

## Placement in Rotation

Small-grain crops | **Fenugreek** | Nitrogen-demanding crops (e.g., maize, wheat, barley)  
*Avoid legumes and protein crops*
Grass pea
*Lathyrus sativus* L.

**GENERAL CHARACTERISTICS**

**ADVANTAGES**
- Excellent forage for sheep
- Drought tolerant
- Grows to a height of 60 cm
- Fixes large amounts of atmospheric nitrogen

**DISADVANTAGES**
- Seeds are toxic if consumed in large quantities
- Large seeds—tricky to sow and compose mixtures
- Transmits root rot (*Aphanomyces*)

**WEED CONTROL:** intermediate

**PEST CONTROL:** DU

**GROWTH FEATURES**

**GERMINATION:** intermediate

**GROWTH RATE:** intermediate over an extended period

**FALLOW-PERIOD DURATION:** short to long

**SOIL**

**TYPE:** does best on somewhat clayey soils; tolerates sandy or calcareous soils

**PREPARATION:** no specific requirements

**EFFECT ON STRUCTURE:** positive (taproot)

**SOWING**

<table>
<thead>
<tr>
<th>Period</th>
<th>Method</th>
<th>Depth</th>
<th>Rate</th>
<th>Cost (€/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Until mid-</td>
<td>Broadcast sowing during stubble ploughing</td>
<td>3–4 cm</td>
<td>40–60 kg/ha</td>
<td>⊗</td>
</tr>
<tr>
<td>September</td>
<td>— cover ground well</td>
<td></td>
<td>TKW = 200 g</td>
<td></td>
</tr>
</tbody>
</table>

**MIXTURES:** can be used with grains (e.g., oat, sorghum, barley)

**TERMINATION**

**Freeze tolerance:**
- Sensitive ≤ -5°C

**MOST EFFECTIVE METHODS**

1. Winter killing + crushing/shredding/stubble ploughing
2. Ploughing

**PLACEMENT IN ROTATION**

- Avoid legumes
- **Grass pea**
- Nitrogen-demanding crops (e.g., maize, wheat, barley, beet, potato)
- Avoid legumes, protein crops, and species that host...
Forage lentil
Lens nigricans

**GENERAL CHARACTERISTICS**

**ADVANTAGES**
- Easy addition to mixtures (small seeds)
- Generates good soil cover—bushy growth form
- Produces large amounts of biomass
- Drought tolerant
- Fixes large amounts of atmospheric nitrogen

**DISADVANTAGES**
- Afflicted by/transmits root rot (*Aphanomyces*)
- Generates very low-lying cover

**WEED CONTROL:** good

**PEST CONTROL:** DU

**GROWTH FEATURES**

**GERMINATION:** fast

**GROWTH RATE:** high

**FALLOW-PERIOD DURATION:** long (4–5 months)

**SOIL**

**TYPE:** all

**PREPARATION:** no specific requirements

**EFFECT ON STRUCTURE:** positive (taproot)

**SOWING**

<table>
<thead>
<tr>
<th>Period</th>
<th>Method</th>
<th>Depth</th>
<th>Rate</th>
<th>Cost (€/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>September/October</td>
<td>Can be sown during harvesting</td>
<td></td>
<td>40 kg/ha</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Broadcast sowing—cover ground</td>
<td>2–3 cm</td>
<td>TKW = 20–30 g</td>
<td></td>
</tr>
</tbody>
</table>

**MIXTURES:** can be used with grains (e.g., oat, barley, rye)

**TERMINATION**

Freeze tolerance: Sensitive ≤ -6°C

**Sensitivity depends on cover development stage**

**MOST EFFECTIVE METHODS**

1. Shredding/crushing (if cover is allowed to develop)
2. Tilling/stubble ploughing

**PLACEMENT IN ROTATION**

Avoid legumes

**FORAGE LENTIL**

Nitrogen-demanding crops (e.g., maize, wheat, barley, beet, potato)

Avoid legumes, protein crops, and species that host

DU: data unavailable

Written by: Adeline Cadillon (ITAB)

With assistance from:
- M. Mangin (ARVALIS), P. Guilhard (farmer), S. Minette (Poitou-Charentes Chamber of Agriculture), J. Champion (Drôme Chamber of Agriculture), J. Bayle (Meurthe and Moselle Chamber of Agriculture), J. Arino (Gers Chamber of Agriculture)
Forage lentil

*Lens nigricans*

**PERSPECTIVES FROM THE FIELD**

**FRÉDÉRIC ARNAUD, MEURTHE AND MOSELLE CHAMBER OF AGRICULTURE**

"Forage lentil produces a rather large amount of biomass. It grows close to the ground. This can cause problems when it comes to weed removal. The lentil is therefore commonly used in mixtures with complementary species, such as mustard or oat, which grow tall and remain erect." ‡

**PHILIPPE GUILCHARD, FARMER IN AQUITAINE, LOT AND GARONNE**

"Freezing temperatures do not always kill the lentil. They need to hit -7 or -8°C and stay there for 3–4 days. As a result, I often have to plough it under. However, I do not plough too deeply because I then plant maize." ‡
Bird's-foot trefoil

*Lotus corniculatus*

**Legumes**

---

### General Characteristics

**Advantages**
- Tolerant of extreme climatic conditions (cold, drought)
- No risk of bolting
- Can serve as forage (bloat safe)
- Fixes large amounts of atmospheric nitrogen

**Disadvantages**
- Slow growth
- Low level of soil cover (height: 10–40 cm)
- Sensitive to high levels of winter precipitation
- Transmits root rot (*Aphanomyces*)

**Weed control:** poor (short plants)

**Pest control:** DU

---

### Growth Features

**Germination:** slow (2–3 weeks)

**Growth rate:** low

**Fallow-period duration:** long

---

### Soil

**Type:** all except waterlogged soils

**Preparation:** fine seedbed

---

### Sowing

<table>
<thead>
<tr>
<th>Period</th>
<th>Method</th>
<th>Depth</th>
<th>Rate</th>
<th>Cost (€/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring, autumn</td>
<td>Row sowing</td>
<td>1–2 cm</td>
<td>10–15 kg/ha</td>
<td>⬤⬤⬤⬤⬤</td>
</tr>
<tr>
<td></td>
<td>Broadcast sowing possible if seeds are buried, pass with roller</td>
<td></td>
<td>TKW = 1–1.5 g</td>
<td></td>
</tr>
</tbody>
</table>

**Mixtures:** can be used with grains (e.g., oat, barley, tall fescue, bromegrass)

---

### Termination

**Freeze tolerance:**
- Hardy < -15°C*

Sensitivity depends on cover development stage

**Most effective methods**
1. Shredding (if allowed to develop)
2. Tilling (stubble plough with winged shanks)

---

### Placement in Rotation

Avoid legumes

**Bird's-foot trefoil**

Nitrogen-demanding crops (e.g., maize, wheat, barley, sorghum)

---

*the Mediterranean variety is not cold tolerant

DU: data unavailable

---

**Written by:**
- Adeline Cadillon (ITAB)
- With assistance from:
  - L. Prieur (CREAB), M. Mangin (ARVALIS), A. Lecat (Nord-Pas de Calais Chamber of Agriculture), P. Gayraud (plant breeder), S. Minette (Poitou-Charentes Chamber of Agriculture), J. Arino (Gers Chamber of Agriculture)

**September 2013**
Yellow lupin
Lupinus luteus

GENERAL CHARACTERISTICS

ADVANTAGES
Hardy and resistant
Can serve as forage (high protein content)
Improves low-fertility soils
Roots release an acid enzyme that facilitates mineral assimilation (e.g., phosphorus)
Does not transmit Aphanomyces
Fixes large amounts of atmospheric nitrogen

WEED CONTROL: poor

Pest control: vulnerable to anthracnose

DISADVANTAGES
Higher temperature requirements
Seeds can be toxic
Susceptible to weed competition (e.g., docks and sorrels or thistles)

GROWTH FEATURES

GERMINATION: slow
GROWTH RATE: high

FALLOW-PERIOD DURATION: intermediate to long (100–180 days)

SOIL

TYPE: shallow, sandy soils; best used in acidic soils

PREPARATION: one or two methods—loosen upper soil layer

EFFECT ON STRUCTURE: positive (extensive root system)

SOARING

<table>
<thead>
<tr>
<th>Period</th>
<th>Method</th>
<th>Depth</th>
<th>Rate</th>
<th>Cost (€/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>September/October</td>
<td>Broadcast or row sowing</td>
<td>3–5 cm</td>
<td>100–150 kg/ha TKW = 120–450 g</td>
<td>⬤⬤⬤⬤⬤</td>
</tr>
</tbody>
</table>

MIXTURES: can be used with spring oat

TERMINATION

Freeze tolerance: Sensitive (spring variety) to very hardy (winter variety) < -15°C

Sensitivity depends on cover development stage

MOST EFFECTIVE METHODS

1. Winter killing + crushing/shredding/stubble ploughing
2. Ploughing/tiling

PLACEMENT IN ROTATION

Avoid legumes

YELLOW LUPIN

Nitrogen-demanding crops (e.g., wheat, Italian ryegrass, rye)

Written by: Adeline Cadillon (ITAB)
With assistance from: M. Mangin (ARVALIS), S. Minette (Poitou-Charentes Chamber of Agriculture), J. Bayle (Meurthe and Moselle Chamber of Agriculture), J. Arino (Gers Chamber of Agriculture)

Sensitivity depends on cover development stage

DU: data unavailable

SEPTMBER 2013
Lucerne
Medicago sativa

GENERAL CHARACTERISTICS

ADVANTAGES
Can serve as forage
Vigorous growth and dense cover
Can interrupt cyclical disease transmission in grains
Fixes large amounts of atmospheric nitrogen
*Mediterranean variety*: drought tolerant but frost sensitive (suited to south)
*Flemish variety*: frost sensitive (suited to north)

WEME CONTROL: intermediate

PEST CONTROL: intermediate, increases risk of *Sitona* weevils

DISADVANTAGES
Termination is complicated
Self toxic (do not plant lucerne as the following cash crop or undersow a lucerne in a lucerne) and causes bloat in livestock
Exerts strong competitive pressure on other species in mixtures
Sensitive to soil compaction, saturation, and trampling
Afflicted by/transmits root rot (*Aphanomyces*)
Seeds must be inoculated (southern France)

GROWTH FEATURES

GERMINATION: fast

GROWTH RATE: low to intermediate

FALLOW-PERIOD DURATION: long

SOIL

TYPE: all except waterlogged, acidic soils (can apply lime)

PREPARATION: fine seedbed

EFFECT ON STRUCTURE: positive (strong fibrous root system)

SOWING

<table>
<thead>
<tr>
<th>Period</th>
<th>Method</th>
<th>Depth</th>
<th>Rate</th>
<th>Cost (€/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring, early autumn</td>
<td>Can be undersown in the spring Broadcast sowing, pass with a roller/harrow Row sowing</td>
<td>1 cm max</td>
<td>20–25 kg/ha TKW = 2–2.5 g</td>
<td>[image]</td>
</tr>
</tbody>
</table>

MIXTURES: small quantities can be mixed with grains (e.g., sorghum, oat)

TERMINATION

Freeze tolerance:
Hardy < -15°C

Sensitivity depends on cover development stage

MOST EFFECTIVE METHODS

1. Shredding
2. Ploughing/tilling

PLACEMENT IN ROTATION

Small-grain crops or end-of-rotation crops

LUCERNE
Nitrogen-demanding crops (e.g., maize, wheat, barley, sorghum)

Written by: Adeline Cadillon (ITAB)
With assistance from J. Bayle (Meurthe and Moselle Chamber of Agriculture), P. Guichard (Farmer), L. Prieur (CREAB), P. Gayraud (plant breeder), S. Minette (Poitou-Charentes Chamber of Agriculture), J. Champion (Drôme Chamber of Agriculture), J. Arino (Gers Chamber of Agriculture)

DU: data unavailable

SEPTEMBER 2013
Water medic
Medicago littoralis

GENERAL CHARACTERISTICS

ADVANTAGES
Can serve as forage
Very vigorous growth, dense cover, competitive and aggressive plant
Rapid production (60–75 days)
Fixes large amounts of atmospheric nitrogen

DISADVANTAGES
Self toxic (do not plant water medic as the following cash crop or undersow a water medic in a water medic)
In mixtures, exerts strong competitive pressure on other species
Just after sowing, vulnerable to drought and competitive pressure from grains (wheat, bluegrass, ryegrass)
Responds negatively to soil compaction and trampling
Afflicted by/transmits root rot (Aphanomyces)

WEED CONTROL: good (suppressive effect)
PEST CONTROL: intermediate

GROWTH FEATURES

GERMINATION: fast
GROWTH RATE: intermediate (if undersown) to high
FALLOW-PERIOD DURATION: intermediate to long

SOIL

TYPE: all except waterlogged, acidic soils
PREPARATION: fine seedbed
EFFECT ON STRUCTURE: positive (strong taproot system; can extend as far down as 2 m)

SOWING

<table>
<thead>
<tr>
<th>Period</th>
<th>Method</th>
<th>Depth</th>
<th>Rate</th>
<th>Cost (€/ha)</th>
</tr>
</thead>
</table>
| Spring, early autumn | Can be undersown in the spring Broadcast sowing, pass with roller/harrow | 1 cm max | 20–25 kg/ha TKW = 2–2.5 g | ☼☼☼☼☼

MIXTURES: small quantities can be mixed with grains (e.g., millet, oat)

TERMINATION

Freeze tolerance: Sensitive ≤ -3°C

Sensitivity depends on cover development stage

MOST EFFECTIVE METHODS
1. Shredding (if allowed to develop)
2. Ploughing/tilling

PLACEMENT IN ROTATION

Small-grain crops or end-of-rotation crops
WATER MEDIC
Nitrogen-demanding crops (e.g., maize, wheat, barley, sorghum)

Written by: Adeline Cadillon (ITAB)
With assistance from: J. Bayle (Meurthe and Moselle Chamber of Agriculture), G. Salitot (Picardie Chamber of Agriculture), M. Mangin (ARVALIS), F. Célette (ISARA-Lyon), J. Arino (Gers Chamber of Agriculture)
PERPECTIVES FROM THE FIELD

Gille Salitot, Picardie Chamber of Agriculture

“...it is best to undersow water medic in spring barley or plant it immediately after the harvest. It is not very useful when the fallow period is long because of its annual life cycle and its establishment costs. In Picardie, you often get disappointing results if you undersow water medic in a winter grain during the spring.”

Alain Lecat, Nord-Pas de Calais Chamber of Agriculture

“...it is a difficult cover crop to terminate. It must be cut at the very base of the stem during an efficient tillage operation.”
White/yellow sweet clover

*Melilotus alba/arvensis*

### GENERAL CHARACTERISTICS

**ADVANTAGES**
- Can serve as forage
- Produces large amounts of biomass (grows as tall as 2 m)
- Can grow on soils that are poor in organic matter
- Fixes large amounts of atmospheric nitrogen

**DISADVANTAGES**
- Biennial
- Termination is complicated
- If terminated improperly, can produce thick cover and become invasive (bushy growth form)
- Terminate before bolting
- Transmits root rot (*Aphanomyces*)

**WEED CONTROL:** intermediate

**PEST CONTROL:** DU

### GROWTH FEATURES

**GERMINATION:** DU

**GROWTH RATE:** high

**FALLOW-PERIOD DURATION:** intermediate to long (80–100)

### SOIL

**TYPE:** deals well with calcareous soils

**PREPARATION:** no specific requirements

**EFFECT ON STRUCTURE:** very positive (extremely strong, deep root system)

### SOWING

<table>
<thead>
<tr>
<th>Period</th>
<th>Method</th>
<th>Depth</th>
<th>Rate</th>
<th>Cost (€/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring, late summer</td>
<td>Can be undersown in the spring</td>
<td>1–3 cm</td>
<td>20 kg/ha</td>
<td>☢☢☢☢</td>
</tr>
<tr>
<td></td>
<td>Broadcast sowing, pass with roller/harrow</td>
<td></td>
<td>TKW = 1–2 g</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Row sowing</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**MIXTURES:** can be used with grains (e.g., sorghum, oat, millet, rye)

### TERMINATION

**Freeze tolerance:**
- Hardy < -15°C

**MOST EFFECTIVE METHODS**
1. Shredding
2. Ploughing/tilling using discs/tines

### PLACEMENT IN ROTATION

- Avoid legumes
- **SWEET CLOVER**
- Nitrogen-demanding crops (e.g., wheat, Italian ryegrass, rye)

Yellow sweet clover may provide better quality green manure. It is shorter and bushier; it also provides more extensive cover.

Written by: Adeline Cadillon (ITAB)
With assistance from:
A. Lecat (Nord-Pas de Calais Chamber of Agriculture), G. Salitot (Picardie Chamber of Agriculture), L. Prieur (CREAB), S. Minette (Poitou-Charentes Chamber of Agriculture), J. Arino (Gers Chamber of Agriculture)
White/yellow sweet clover

*Melilotus alba/arvensis*

**PERPECTIVES FROM THE FIELD**

**GILLESALITO, PICARDIE CHAMBER OF AGRICULTURE**

“Depending on the conditions the year the cover is established, biomass levels may be rather modest going into the winter. If you plant sweet clover, be careful to properly manage it. Because it is a biennial plant, the following year’s regrowth can end up competing with the cash crop.”

**ALAIN LECAT, NORD-PAS DE CALAIS CHAMBER OF AGRICULTURE**

“It is a great cover crop if you want to increase soil nitrogen content. However, it is hard to terminate unless you are not going to farm the field or you are planting roots and tubers in the late spring.”
**GENERAL CHARACTERISTICS**

**ADVANTAGES**
- Hardy
- Drought tolerant
- Can be undersown in grains
- Deals well with light competition
- Fixes large amounts of atmospheric nitrogen

**DISADVANTAGES**
- Biennial
- Transmits root rot (*Aphanomyces*)

**WEED CONTROL:** good (creates extensive cover)

**PEST CONTROL:** DU

**GROWTH FEATURES**

**GERMINATION:** fast

**GROWTH RATE:** intermediate (during fallow period, summer) to high (in mixtures)

**FALLOW-PERIOD DURATION:** intermediate to long

**SOIL**

**TYPE:** all, especially calcareous soils

**PREPARATION:** no specific requirements

**EFFECT ON STRUCTURE:** positive (small taproot with fibrous branches; can extend as far down as 50 cm)

**SOWING**

<table>
<thead>
<tr>
<th>Period</th>
<th>Method</th>
<th>Depth</th>
<th>Rate</th>
<th>Cost (€/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring to autumn</td>
<td>Broadcast sowing Use of roller or harrow recommended</td>
<td>3 cm</td>
<td>10–15 kg/ha TKW = 1.8 g</td>
<td>␪ ␪ ␪ ␪ ␪</td>
</tr>
</tbody>
</table>

**MIXTURES:** can be used with grains (oat, rye, maize), composites (sunflower, nyger), or nitrogen-demanding crops (e.g., wheat, rye, sorghum, maize)

**TERMINATION**

**Freeze tolerance:**
- Hardy < -15°C

**MOST EFFECTIVE METHODS**
1. Shredding
2. Ploughing/tilling

**Placement in Rotation**

- Avoid legumes
- **BLACK MEDIC:** Nitrogen-demanding crops (e.g., wheat, rye, sorghum, maize)

DU: data unavailable
Black medic
Medicago lupulina

PERSPECTIVES FROM THE FIELD

Gille Salitot, Picardie Chamber of Agriculture

“Compared to Haifa white clover, Virgo black medic displays more limited development. The sowing rate is higher, which means establishment costs are higher as well. It generates low-lying cover.”

Alain Lecat, Nord-Pas de Calais Chamber of Agriculture

“It is a cover you can use on calcareous soils. It can easily be reproduced year after year. Black medic can grow on poor-quality soils and tolerates drought conditions. However, it is more expensive than other cover crops. It can do a good job suppressing weeds after grain crops are harvested.”

Frédéric Arnaud, Meurthe and Moselle Chamber of Agriculture

“I am a big fan of black medic, when it is sown in April or May, because it yields lots of biomass, and a bit more nitrogen than white clover. If it is undersown in a grain crop, there are not any issues at harvest time because it produces low-lying cover.”
Field pea

Pisum arvense

GENERAL CHARACTERISTICS

ADVANTAGES
Easy to terminate
Can serve as forage
Fixes large amounts of atmospheric nitrogen

DISADVANTAGES
Large seeds—some mixtures may be complicated
Low level of growth
Afflicted by/transmits root rot (Aphanomyces)
Drought intolerant

WEED CONTROL: poor
PEST CONTROL: vulnerable to parasites and anthracnose

GROWTH FEATURES

GERMINATION: fast
GROWTH RATE: intermediate
FALLOW-PERIOD DURATION: intermediate

SOIL

TYPE: all except waterlogged soils
PREPARATION: no specific requirements, but performs poorly if ploughpans are present
EFFECT ON STRUCTURE: positive (fibrous root system)

SOWING

<table>
<thead>
<tr>
<th>Period</th>
<th>Method</th>
<th>Depth</th>
<th>Rate</th>
<th>Cost (€/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before early October</td>
<td>Broadcast sowing while stubble ploughing Use of roller or harrow recommended</td>
<td>2–3 cm</td>
<td>100–250 kg/ha TKW = 220–280 g</td>
<td>⦿⦿⦿⦿⦿ O ⦿⦿⦿⦿⦿</td>
</tr>
</tbody>
</table>

MIXTURES: can be used with grains (e.g., oat) or brassicas (mustard)

TERMINATION

FREEZE TOLERANCE:
Extremely sensitive (spring variety)
to hardy (winter variety)
\(\leq -10^\circ\text{C}\)

SENSITIVITY DEPENDS ON COVER DEVELOPMENT STAGE

MOST EFFECTIVE METHODS
1. Winter killing + crushing
2. Ploughing/tilling

PLACEMENT IN ROTATION

Avoid legumes
FIELD PEA
Nitrogen-demanding crops (e.g., wheat, rye, sorghum, maize, sunflower)
Avoid using peas as cover crops in rotations with peas

Written by: Adeline Cadillon (ITAB)
With assistance from: P. Guichard (farmer), Loïc Prieur (CREAB), S. Minette (Poitou-Charentes Chamber of Agriculture), J. Bayle (Meurthe and Moselle Chamber of Agriculture), J. Arino (Gers Chamber of Agriculture)

SEPTEMBER 2013
The field pea stands tall thanks to its erect form and tendrils. It works extremely well in cover crop mixtures.
Forage pea

*Pisum sativum*

**GENERAL CHARACTERISTICS**

**ADVANTAGES**
- Fairly easy to establish
- Produces large amounts of biomass in the autumn
- Fixes large amounts of atmospheric nitrogen

**DISADVANTAGES**
- Not easily winter killed
- Seedlings are drought intolerant
- Afflicted by/transmits root rot (*Aphanomyces*)
- Very vulnerable to eyespot

**WEED CONTROL:** poor

**PEST CONTROL:** DU

**GROWTH FEATURES**

**GERMINATION:** fast

**GROWTH RATE:** intermediate to high

**FALLOW-PERIOD DURATION:** intermediate to long

**SOIL**

**TYPE:** all

**PREPARATION:** no specific requirements

**EFFECT ON STRUCTURE:** intermediate (somewhat deep fibrous root system)

**SOWING**

<table>
<thead>
<tr>
<th>Period</th>
<th>Method</th>
<th>Depth</th>
<th>Rate</th>
<th>Cost (€/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before early October</td>
<td>Broadcast sowing while stubble ploughing Use of roller or harrow recommended</td>
<td>1–2 cm</td>
<td>40–60 kg/ha TKW = 100–300 g</td>
<td>DU: data unavailable</td>
</tr>
</tbody>
</table>

**Mixtures:** can be used with grains (e.g., sorghum, spring oat, millet, rye)

**TERMINATION**

**Freeze tolerance:**
- Hardy
- < -15°C

**MOST EFFECTIVE METHODS**
1. Winter killing + crushing/shredding
2. Ploughing

**PLACEMENT IN ROTATION**

- Avoid legumes
- **FORAGE PEA**
  - Nitrogen-demanding crops (e.g., wheat, rye, sorghum, barley)
  - Avoid using peas as cover crops in rotations with peas
Forage pea

*Pisum sativum*

**Perspectives from the Field**

FRÉDÉRIC ARNAUD, MEURTHE AND MOSELLE CHAMBER OF AGRICULTURE

On the forage pea, leaves are found lower down than on the field pea. When the forage pea is used as a cover crop, weeds may be more prevalent. The species also needs to be grown with a companion crop because it can grow tall but lacks tendrils.
Sweetvetch
Hedysarum species

**General Characteristics**

**Advantages**
- Provides good cover and grows rapidly
- Can serve as forage (palatable and bloat safe)
- Drought tolerant (hardy)
- Fixes large amounts of atmospheric nitrogen

**Disadvantages**
- Exerts only intermediate competitive pressure on weeds during early growth
- Perennial
- Performs poorly under wet conditions
- Availability of organic seeds is limited in France
- Transmits root rot (*Aphanomyces*)

**Weed Control:** good

**Pest Control:** DU

**Growth Features**

**Germination:** intermediate

**Growth Rate:** intermediate

**Fallow-period Duration:** intermediate to long

**Soil**

**Type:** nutrient-poor, dry calcareous soils

**Preparation:** no specific requirements

**Effect on Structure:** very positive (deep taproot)

**Sowing**

<table>
<thead>
<tr>
<th>Period</th>
<th>Method</th>
<th>Depth</th>
<th>Rate</th>
<th>Cost (€/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Late summer</td>
<td>Can be undersown in the spring</td>
<td>2–3 cm</td>
<td>40–45 kg/ha*</td>
<td>⬤⬤⬤⬤⬤</td>
</tr>
<tr>
<td>Early autumn</td>
<td>Broadcast sowing</td>
<td></td>
<td>TKW = 20–22 g</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Use of roller recommended</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Mixtures:** can be used with grains (e.g., sorghum, oat, millet, rye) or lucerne

**Germination:** intermediate

**Growth Rate:** intermediate

**Fallow-period Duration:** intermediate to long

**Soil**

**Type:** nutrient-poor, dry calcareous soils

**Preparation:** no specific requirements

**Effect on Structure:** very positive (deep taproot)

**Sowing**

<table>
<thead>
<tr>
<th>Period</th>
<th>Method</th>
<th>Depth</th>
<th>Rate</th>
<th>Cost (€/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Late summer</td>
<td>Can be undersown in the spring</td>
<td>2–3 cm</td>
<td>40–45 kg/ha*</td>
<td>⬤⬤⬤⬤⬤</td>
</tr>
<tr>
<td>Early autumn</td>
<td>Broadcast sowing</td>
<td></td>
<td>TKW = 20–22 g</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Use of roller recommended</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Mixtures:** can be used with grains (e.g., sorghum, oat, millet, rye) or lucerne

**Termination**

**Freeze tolerance:** Hardy ≤ -15°C

**Sensitivity depends on cover development stage

**Placement in Rotation**

Avoid legumes  **Sweetvetch**  Nitrogen-demanding crops (e.g., wheat, rye, sorghum, maize)

**Most Effective Methods**

1. Shredding
2. Ploughing/tilling

**Biomass**

<table>
<thead>
<tr>
<th>Soil nitrogen capture</th>
<th>Nitrogen release</th>
</tr>
</thead>
<tbody>
<tr>
<td>intermediate</td>
<td>low</td>
</tr>
<tr>
<td></td>
<td>intermediate to high</td>
</tr>
</tbody>
</table>

To obtain proper cover development

In southern France, common sainfoin (*Onobrychis vicifolia*; an annual) can be used as a potential replacement.

*40–50 kg of hulled seeds or 150–180 kg/ha of unhulled seeds

DU: data unavailable

Written by: Adeline Cadillon (ITAB)

With assistance from: P. Gayraud (plant breeder), L. Prieur (CREAB), J. Arino (Gers Chamber of Agriculture)

*September 2013*
White clover
Trifolium repens
(intermediate variety)

GENERAL CHARACTERISTICS

ADVANTAGES
More persistent and robust than other clovers
Tolerates drought once established
Can serve as forage
Provides good soil cover (propagates using stolons)
Fixes large amounts of atmospheric nitrogen

DISADVANTAGES
Perennial
Slow, potentially difficult establishment (water stress)
Transmits root rot (*Aphanomyces*)
Attracts mice and other rodents
Causes bloat in livestock
Susceptible to competitive pressures when undersown

WEED CONTROL: intermediate

Pest control: DU

GROWTH FEATURES

Germination: slow
Growth rate: intermediate
Fallow-period duration: long

SOIL

Type: all
Preparation: very fine seedbed
Effect on structure: positive (well-developed fibrous root system)

SOWING

<table>
<thead>
<tr>
<th>Period</th>
<th>Method</th>
<th>Depth</th>
<th>Rate</th>
<th>Cost (€/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>February</td>
<td>Broadcast sowing, use of roller recommended</td>
<td>1 cm</td>
<td>4–5 kg/ha</td>
<td>TKW = 0.60–0.70 g</td>
</tr>
</tbody>
</table>

Mixtures: can be used with mustard or rye

TERMINATION

Freeze tolerance: Hardy < -15°C

Most effective methods

1. Ploughing
2. Tilling

Placement in rotation

Spring grains (e.g., barley, maize) ✅
Nitrogen-demanding crops (e.g., wheat, rye, sorghum, maize)
Undersown in a winter grain in the spring

DU: data unavailable

Written by: Adeline Cadillon (ITAB)
With assistance from: F. Celette (ISARA-Lyon), P. Guichard (farmer), G. Salitot (Picardie Chamber of Agriculture), L. Prieur (CREAB), S. Minette (Poitou-Charentes Chamber of Agriculture), F. Arnaud (Meurthe and Moselle Chamber of Agriculture), A. Lecat (Nord-Pas de Calais Chamber of Agriculture), J. Bayle (Meurthe and Moselle Chamber of Agriculture), J. Arino (Gers Chamber of Agriculture)
If used over several years, Haifa white clover displays a similar degree of development to that of red clover. There are differences between varieties. If the cover crop is undersown, white clover causes fewer problems than red clover because it does not grow up through the following cash crop. Furthermore, white clover propagates via stolons, which helps fill in post-harvest gaps in the cover.

It is a cover you can use everywhere, and it can easily be reproduced year after year. Although white clover can be sown at any time of year, it is best done in early spring (undersown in grain crops in the full tillering stage).

This cover crop produces significant biomass and has a rather low-lying growth form. It is a good compromise species for undersowing in a pre-existing cash crop. However, it tends to attract field mice.

It is a good cover crop to use when employing direct drilling. While it works well, it must be properly established because it will allow weeds to grow if it is too sparse.
Berseem clover

*Trifolium alexandrinum*

**General characteristics**

**Advantages**

- Drought tolerance and frost sensitivity vary for different varieties
- Provides good cover
- Can serve as forage (palatable and bloat safe)

**Disadvantages**

- Appeals to slugs
- Transmits root rot (*Aphanomyces*)
- Difficult to establish
- Susceptible to competitive pressures when undersown

**Weed control:** intermediate to good

**Pest control:** DU

**Growth features**

**Germination:** rather fast

**Growth rate:** high

**Fallow-period duration:** short to intermediate

**Soil**

**Type:** all; can be grown in acidic soils

**Preparation:** stubble ploughing, establishment of a fine seedbed

**Effect on structure:** positive (intermediate system—taproot and fibrous roots)

**Sowing**

<table>
<thead>
<tr>
<th>Period</th>
<th>Method</th>
<th>Depth</th>
<th>Rate</th>
<th>Cost (€/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring, summer, autumn</td>
<td>Can be undersown in the spring Broadcast sowing, pass with roller</td>
<td>1–2 cm</td>
<td>20–25 kg/ha</td>
<td>TKW = 2–3 g</td>
</tr>
</tbody>
</table>

**Mixtures:** can be used with grasses (e.g., ryegrass) or spring brassicas

**Termination**

**Freeze tolerance:**
- Sensitive ≤ -5°C

Sensitivity depends on cover development stage

**Most effective methods**

1. Winter killing + crushing/shredding
2. Ploughing

**Placement in rotation**

- Avoid legumes
- Berseem clover
- Nitrogen-demanding crops (e.g., wheat, rye, sorghum, maize)

Written by: Adeline Cadillon (ITAB)

With assistance from: G. Salitot (Picardie Chamber of Agriculture), L. Prieur (CREAB), P. Gayraud (plant breeder), S. Minette (Poitou-Charentes Chamber of Agriculture), A. Lecat (Nord-Pas de Calais Chamber of Agriculture), J. Arino (Gers Chamber of Agriculture)

SEPTEMBER 2013
In Picardie, you get disappointing results if you undersow berseem clover in a winter grain during the spring. Some varieties are not capable of repeat flowering. After the harvest, they do not grow back at all or only a little. In the summer, berseem clover must be planted early (before the end of July) to have any hope of heading into the winter with significant amounts of biomass.

Berseem clover should be undersown later in the season because of its long, slender growth form and its ability to grow tall very quickly (can compete with grain crop in place).
**GENERAL CHARACTERISTICS**

**ADVANTAGES**
- Very hardy
- Provides good cover
- Easy to put into place
- Can serve as forage
- Fixes large amounts of atmospheric nitrogen

**DISADVANTAGES**
- Hard to terminate
- Tricky to establish
- Susceptible to competitive pressures when undersown
- Develops poorly if temperatures are very cold
- Transmits root rot (*Aphanomyces*)

**WEED CONTROL:** intermediate
**PEST CONTROL:** DU

**GROWTH FEATURES**

**GERMINATION:** fast
**GROWTH RATE:** low to intermediate
**FALLOW-PERIOD DURATION:** intermediate to long

**SOIL**

**TYPE:** all

**PREPARATION:** stubble ploughing, establishment of a fine seedbed

**EFFECT ON STRUCTURE:** positive (fibrous root system)

**SOWING**

<table>
<thead>
<tr>
<th>Period</th>
<th>Method</th>
<th>Depth</th>
<th>Rate</th>
<th>Cost (€/ha)</th>
</tr>
</thead>
</table>
| February to October | Can be undersown in the spring  
Broadcast sowing, pass with roller | 1–2 cm | 20–25 kg/ha  
TKW = 2–3 g | ⬤⬤⬤⬤

**MIXTURES:** can be used with grains (e.g., sorghum, oat, millet, rye)

**TERMINATION**

Freeze tolerance: Hardy ≤ -15°C

**MOST EFFECTIVE METHODS**
1. Winter killing + crushing/shredding
2. Ploughing

**PLACEMENT IN ROTATION**

Avoid legumes **CRIMSON CLOVER** Nitrogen-demanding crops (e.g., wheat, rye, sorghum, maize)

Written by: Adeline Cadillon (ITAB)
With assistance from: F. Célette (ISARA), L. Prieur (CREAB), P. Gayraud (plant breeder), J. Arino (Gers Chamber of Agriculture)

September 2013
Red clover

*Trifolium pratense*

### General Characteristics

#### Advantages
- Good-quality establishment
- Can serve as forage
- Produces large amounts of biomass in mixtures and during the fallow period
-Fixes large amounts of atmospheric nitrogen

#### Disadvantages
- Tricky to establish
- Causes bloat in livestock
- Susceptible to competitive pressures when undersown
- Transmits root rot (*Aphanomyces*)

**Weed control:** excellent  
**Pest control:** DU

### Growth Features

#### Germination:
fast

#### Growth Rate:
good to high

#### Fallow-period Duration:
long

### Soil

**Type:** all  
**Preparation:** somewhat fine seedbed  
**Effect on Structure:** positive (fibrous root system)

### Sowing

<table>
<thead>
<tr>
<th>Period</th>
<th>Method</th>
<th>Depth</th>
<th>Rate</th>
<th>Cost (€/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>February to October</td>
<td>Can be undersown in the spring</td>
<td>1–2 cm</td>
<td>20–25 kg/ha</td>
<td>DU</td>
</tr>
<tr>
<td></td>
<td>Broadcast sowing, pass with roller/harrow</td>
<td></td>
<td>TKW = 1.8 g</td>
<td></td>
</tr>
</tbody>
</table>

**Mixtures:** can be used with grains (e.g., sorghum, oat, barley, millet, ryegrass)

### Termination

**Freeze tolerance:**  
Hardy < -15°C

**Most Effective Methods**

1. Winter killing + crushing/shredding  
2. Ploughing

### Placement in Rotation

- Avoid legumes  
- **Red Clover:** Nitrogen-demanding crops (e.g., wheat, rye, sorghum, maize)

DU: data unavailable
Perspectives from the Field

Gille Salitot, Picardie Chamber of Agriculture

Red clover generally produces large amounts of biomass. Varieties differ in their vulnerability to powdery mildew, limiting potential changes in autumn cover crops. After a period of freezing temperatures, this cover crop is easy to terminate via ploughing.

Alain Lecat, Nord-Pas de Calais Chamber of Agriculture

If undersown, red clover displays an intermediate level of aggressiveness and provides an average amount of cover. The sowing date can be used as a tool for limiting its degree of aggressiveness.

Frédéric Arnaud, Meurthe and Moselle Chamber of Agriculture

Red clover gets first place for its biomass and nitrogen production! It provides excellent cover and grows sufficiently high. However, be careful because it can be a rather intense competitor when it has been undersown.

Philippe Guichard, Farmer in Aquitaine, Lot and Garonne

Red clover has a greater seedling density and provides more extensive cover than white clover. My red clover cover crop is followed by maize or sunflower. However, it must be shredded before the sunflower is planted.

Arnaud Schmitt, Farmer in Meuse, Lorraine

Planted between wheat and spring barley, red clover can be used to break up the crop rotation and suppress weeds. Either I undersow it, or I sow it directly in the autumn. However, when it is undersown, it grows through the cash crop in place! The advantage that red clover has over other cover crops is that it produces a lot of biomass and nitrogen for the following cash crop.
Persian clover

Trifolium resupinatum

**General characteristics**

**Advantages**
- Grows more quickly than crimson clover in the summer
- Can be used as a relay crop
- Rather drought tolerant
- Fixes large amounts of atmospheric nitrogen

**Disadvantages**
- Tricky to establish
- Provides average level of cover
- Transmits root rot (*Aphanomyces*)
- Susceptible to competitive pressures when undersown

**Weed control**: intermediate

**Pest control**: DU

**Growth features**

**Germination**: intermediate

**Growth rate**: intermediate

**Fallow-period duration**: intermediate to long

**Soil**

**Type**: all, including heavy, waterlogged, and non-acidic soils (pH>6)

**Preparation**: fine seedbed

**Effect on structure**: positive (intermediate system—taproot and fibrous roots; can extend down 25 cm)

**Sowing**

<table>
<thead>
<tr>
<th>Period</th>
<th>Method</th>
<th>Depth</th>
<th>Rate</th>
<th>Cost (€/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>February to October</td>
<td>Can be undersown in the spring Broadcast sowing, pass with roller</td>
<td>1–2 cm</td>
<td>10–15 kg/ha TKW = 2–3 g</td>
<td>![Cost symbol]</td>
</tr>
</tbody>
</table>

**Mixtures**: can be used with grains (e.g., sorghum, oat, millet)

**Termination**

**Freeze tolerance**: Hardy < -15°C

**Most effective methods**

1. Winter killing + crushing
2. Ploughing/tilling

**Placement in rotation**

**Avoid legumes**

**Persian clover**

Nitrogen-demanding crops (e.g., wheat, rye, sorghum, maize)

DU: data unavailable

Written by: Adeline Cadillon (ITAB)

With assistance from: L. Prieur (CREAB), P. Gayraud (plant breeder), A. Lecat (Nord-Pas de Calais Chamber of Agriculture), J. Arino (Gers Chamber of Agriculture)
**Vetch**

*Vicia sativa*

### General Characteristics

**Advantages**

- Easy to establish
- Produces large amounts of biomass
- Should be used as part of a mixture
- Fixes large amounts of atmospheric nitrogen

**Disadvantages**

- Transmits root rot (*Aphanomyces*)
- Drought intolerant
- Has trouble growing in nutrient-poor soils
- Slow growth rate
- Droops if grown as a single cover crop; needs a companion crop

**Weed control:** intermediate

**Pest control:** DU

### Growth Features

**Germination:** fast

**Growth rate:** low to intermediate

**Fallow-period duration:** intermediate

### Soil

**Type:** all

**Preparation:** no specific requirements

**Effect on structure:** positive (intermediate system—taproot and fibrous roots)

### Sowing

<table>
<thead>
<tr>
<th>Period</th>
<th>Method</th>
<th>Depth</th>
<th>Rate</th>
<th>Cost (€/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before early October</td>
<td>Can be sown as part of a mixture</td>
<td>2 cm</td>
<td>30–50 kg/ha</td>
<td>☠☠☠☠☠</td>
</tr>
<tr>
<td></td>
<td>Broadcast sowing, pass with roller</td>
<td></td>
<td>TKW = 45–75 g</td>
<td></td>
</tr>
</tbody>
</table>

**Mixtures:** can be grown with grains (e.g., sorghum, oat, barley, rye, wheat, triticale)

### Termination

**Freeze tolerance:**

- Sensitive (spring variety)
- Hardy (winter variety)

**Most effective methods**

1. Winter killing + crushing
2. Ploughing/tilling

Sensitivity depends on cover development stage

### Placement in Rotation

- Avoid legumes and spring barley
- **Vetch**
- Nitrogen-demanding crops (e.g., wheat, rye, sorghum, maize)

**DU:** data unavailable
Perspectives from the Field

Frédéric Arnaud, Meurthe and Moselle Chamber of Agriculture

“Vetch cannot really be used during the summer fallow period in Lorraine because its timing is a bit late. However, it does produce abundant biomass if it is properly established. It can be mixed with oat, for example.”

David Hypolite, Farmer in Meurthe and Moselle

“It is helpful to use vetch as part of a mixture. For example, before a grain cash crop (spring wheat), I employ a cover crop mixture of oat, vetch, and sunflower. It functions like a nitrogen factory if planted early, before August 1 in northeastern France. It allows serves as an alternative legume because organic crop rotations tend to be legume heavy.”
Hairy vetch
Vicia villosa

**GENERAL CHARACTERISTICS**

**ADVANTAGES**
- Very cold tolerant
- Pest resistant (allelopathic activity)
- Semi-erect growth form; less vulnerable to eyespot than common vetch
- Fixes large amounts of atmospheric nitrogen

**WEED CONTROL:** good

**PEST CONTROL:** DU

**DISADVANTAGES**
- Transmits root rot (*Aphanomyces*)

**GROWTH FEATURES**

**GERMINATION:** fast

**GROWTH RATE:** intermediate

**FALLOW-PERIOD DURATION:** intermediate

**SOIL**

**TYPE:** all

**PREPARATION:** no specific requirements

**EFFECT ON STRUCTURE:** positive (fibrous root system)

**SOWING**

<table>
<thead>
<tr>
<th>Period</th>
<th>Method</th>
<th>Depth</th>
<th>Rate</th>
<th>Cost (€/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before early</td>
<td>Can be sown as part of a mixture</td>
<td>2–3 cm</td>
<td>30–50 kg/ha</td>
<td>⬤⬤⬤⬤⬤</td>
</tr>
<tr>
<td>October</td>
<td>Broadcast sowing, pass with roller</td>
<td></td>
<td>TKW = 32 g</td>
<td></td>
</tr>
</tbody>
</table>

**MIXTURES:** can be used with grains (e.g., sorghum, oat, barley, millet)

**TERMINATION**

**Freeze tolerance:**
Hardy < -15°C

**MOST EFFECTIVE METHODS**
1. Winter killing + crushing
2. Ploughing/tilling

**Sensitivity depends on cover development stage**

**PLACEMENT IN ROTATION**

Avoid legumes and spring barley

**Hairy vetch**

Nitrogen-demanding crops (e.g., wheat, rye, sorghum, maize)

DU: data unavailable
Spring oat
Avena sativa

GENERAL CHARACTERISTICS

ADVANTAGES
- Rapid growth
- Tolerant of warm, dry conditions
- Strong allelopathic activity
- Positive effect on soil structure (0–25 cm)
- Can serve as forage
- More frost sensitive than winter oat

WEED CONTROL: intermediate to good

Pest control: susceptible to crown rust and BYD

DISADVANTAGES
- Somewhat susceptible to crown rust in nitrogen-poor soils (more resistant than winter oat)
- Host plant for aphids that vector barley yellow dwarf (BYD)

GROWTH FEATURES

Germination: fast

GROWTH RATE: high

Fallow-period duration: intermediate to long

SOIL

Type: all

Preparation: no specific requirements

Effect on structure: positive (deep fibrous root system)

SOWING

<table>
<thead>
<tr>
<th>Period</th>
<th>Method</th>
<th>Depth</th>
<th>Rate</th>
<th>Cost (€/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>July to early</td>
<td>Row sowing</td>
<td>2–3 cm</td>
<td>100–120 kg/ha TKW = 35–50 g</td>
<td></td>
</tr>
<tr>
<td>October</td>
<td>Broadcast sowing, pass with roller</td>
<td></td>
<td></td>
<td>● ● ● ● ● ●</td>
</tr>
</tbody>
</table>

Mixtures: can be used with vetch, forage lentil, forage pea, or faba bean, etc.

TERMINATION

Freeze tolerance:
Sensitive ≤ -3°C

Sensitivity depends on cover development stage

MOST EFFECTIVE METHODS

1. Winter killing + crushing
2. Ploughing/light tilling

Placement in rotation

Avoid grasses  SPRING OAT

Spring legumes (e.g., pea, lentil, vetch), maize, sunflower, etc.
Avoid grains

To obtain proper cover development

Oat regrowth can be used as a cover crop.
**GENERAL CHARACTERISTICS**

**ADVANTAGES**
- Rapid growth
- Strong allelopathic activity
- Positive effect on soil structure (0-15 cm)
- Can serve as forage

**DISADVANTAGES**
- Very susceptible to crown rust in nitrogen-poor soils
- Host plant for aphids vectoring barley yellow dwarf (BYD)

**WEED CONTROL**: intermediate to good

**PEST CONTROL**: susceptible to crown rust and BYD

**GROWTH FEATURES**

**GERMINATION**: fast

**GROWTH RATE**: high

**FALLOW-PERIOD DURATION**: long

**SOIL**

**TYPE**: all

**PREPARATION**: no specific requirements

**EFFECT ON STRUCTURE**: positive (fibrous root system)

**SOWING**

<table>
<thead>
<tr>
<th>Period</th>
<th>Method</th>
<th>Depth</th>
<th>Rate</th>
<th>Cost (€/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>July to October</td>
<td>Row sowing, Broadcast sowing</td>
<td>2–3 cm</td>
<td>100–120 kg/ha</td>
<td>●●●●</td>
</tr>
<tr>
<td></td>
<td>Broadcast sowing, pass with roller</td>
<td></td>
<td>TKW = 35–50 g</td>
<td>●●●●</td>
</tr>
</tbody>
</table>

**MIXTURES**: can be used with vetch, forage lentil, etc.

**TERMINATION**

**Freeze tolerance**: Hardy ≤ -13°C

**Sensitivity depends on cover development stage**

**MOST EFFECTIVE METHODS**

1. Winter killing + crushing
2. Ploughing/light tilling

**PLACEMENT IN ROTATION**

- Avoid grasses
- **WINTER OAT**: Spring legumes (e.g., pea, lentil, vetch), maize, sunflower, etc.
  - Avoid grains

**Written by**: Adeline Codillon (ITAB)

**With assistance from**: J. Arino (Gers Chamber of Agriculture)
Winter oat
*Avena sativa*

**PERSPECTIVES FROM THE FIELD**

**DAVID HYPOLITE, FARMER IN MEURTHE AND MOSELLE**

Winter oat does a good job of catching nitrogen left in the soil by the preceding cash crop. I plant it before wheat or spring barley, and do so rather late, because there is a significant risk of crown rust otherwise. Oat is also the companion crop in my vetch-oat-sunflower mixture.
Black oat
Avena strigosa

**GENERAL CHARACTERISTICS**

**ADVANTAGES**
- Resistant to crown rust and barley yellow dwarf (BYD)
- Tolerates dry conditions in the late summer
- Displays significant allelopathic activity
- Can serve as forage

**DISADVANTAGES**
- Development is slow if seedlings experience hot temperatures
- Host plant for aphids

**WEED CONTROL:** DU

**PEST CONTROL:** intermediate

**GROWTH FEATURES**

- **GERMINATION:** fast
- **GROWTH RATE:** high
- **FALLOW-PERIOD DURATION:** long

**SOIL**

- **TYPE:** all
- **PREPARATION:** no specific requirements
- **EFFECT ON STRUCTURE:** positive (fibrous root system)

**SOWING**

<table>
<thead>
<tr>
<th>Period</th>
<th>Method</th>
<th>Depth</th>
<th>Rate</th>
<th>Cost (€/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>July to early</td>
<td>Row sowing recommended, then pass with roller</td>
<td>2 cm</td>
<td>30–40 kg/ha</td>
<td></td>
</tr>
<tr>
<td>October</td>
<td>Broadcast sowing—covers ground well</td>
<td></td>
<td>TKW = 35–50 g</td>
<td></td>
</tr>
</tbody>
</table>

**MIXTURES:** can be used with vetch, clover, faba bean, etc.

**TERMINATION**

- **Freeze tolerance:** Sensitive ≤ -2 to -3°C
- **MOST EFFECTIVE METHODS**
  1. Winter killing + crushing
  2. Ploughing/light tilling

**PLACEMENT IN ROTATION**

<table>
<thead>
<tr>
<th>Avoid grasses</th>
<th><strong>BLACK OAT</strong></th>
<th>Spring legumes (e.g., pea, lentil, vetch), maize, sunflower, etc.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>BLACK OAT</strong></td>
<td>Avoid grasses</td>
</tr>
</tbody>
</table>

**Biomass**  | **Soil nitrogen capture** | **Nitrogen release** |
----------------------------------------------------
intermediate to high                               | intermediate to high  | low to intermediate |

To obtain proper cover development

**SPECIAL FEATURES**

- TKW = 35–50 g
- Biomass
- Soil nitrogen capture
- Nitrogen release
- Intermediate to high
- Low to intermediate

**SEPTEMBER 2013**

Written by: Adeline Cadillon (ITAB)

With assistance from: S. Minette (Poitou-Charentes Chamber of Agriculture), M. Pottier (CORAB), J. Arino (Gers Chamber of Agriculture)
Black oat
Avena strigosa

**PERSPECTIVES FROM THE FIELD**

FRÉDÉRIC ARNAUD, MEURTHE AND MOSELLE CHAMBER OF AGRICULTURE

“Black oat is much more resistant to crown rust than spring white oat is. However, the cover crop can fail if planted in nitrogen-poor soil. This species, which has a low TKW, is recommended for use in mixtures. Black oat seeds display a high level of dormancy, so watch out for the re-emergence of previously planted seeds.”

JÉRÔME LABREUCHE, ARVALIS PLANT INSTITUTE

“Black oat comes from Europe. However, it was bred in South America to produce more biomass and forage. It goes under different names, including diploid oat, Brazilian oat, forage oat, and Avena strigosa. It grows more rapidly than our spring oats. It is often still growing in the winter, and its stems freeze easily. However, growth can take off again in the spring from new tillers that sprout at the plant’s base. It is more resistant than common oat is to viral diseases and crown rust. It has a low TKW.”
Foxtail millet
Panicum germanicum

**GENERAL CHARACTERISTICS**

**ADVANTAGES**
- Tolerates heat
- No regrowth
- Positive effect on soil structure

**DISADVANTAGES**
- Susceptible to water stress during early development
- Seedling growth will be complicated if weeds or regrowth present

**WEED CONTROL:** good

**PEST CONTROL:** DU

**GROWTH FEATURES**

**GERMINATION:** fast

**GROWTH RATE:** high

**FALLOW-PERIOD DURATION:** intermediate

**SOIL**

**TYPE:** all; grows well on nutrient-poor calcareous soils

**PREPARATION:** no specific requirements

**EFFECT ON STRUCTURE:** positive (deep fibrous root system)

**SOWING**

<table>
<thead>
<tr>
<th>Period</th>
<th>Method</th>
<th>Depth</th>
<th>Rate</th>
<th>Cost (€/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>July-August</td>
<td>Row sowing recommended, then pass with roller</td>
<td>1 cm</td>
<td>20–30 kg/ha</td>
<td>●●●●●</td>
</tr>
<tr>
<td></td>
<td>Broadcast sowing—covers ground well</td>
<td></td>
<td>TKW = 2–3 g</td>
<td></td>
</tr>
</tbody>
</table>

**MIXTURES:** can be used with legumes (e.g., berseem clover, Persian clover, forage lentil)

**TERMINATION**

**MOST EFFECTIVE METHODS**
1. Winter killing + crushing
2. Ploughing/tilling

**Freeze tolerance:**
- Very sensitive ≤ 0°C

Sensitivity depends on cover development stage

**PLACEMENT IN ROTATION**

Avoid grasses | Foxtail millet | Spring legumes (e.g., pea, lentil, vetch), sunflower, etc.

DU: data unavailable

Written by: Adeline Cadillon (ITAB)
With assistance from: S. Minette (Poitou-Charentes Chamber of Agriculture), M. Pottier (CORAB), J. Arino (Gers Chamber of Agriculture)

September 2013
Foxtail millet
*Panicum germanicum*

**PER SPECTIVES FROM THE FIELD**

JÉRÔME LABREUCHE, ARVALIS PLANT INSTITUTE

This summer grass can be sown in late spring or early summer to obtain a second harvest of forage.

It is cold intolerant and frost sensitive.
Proso millet

Panicum miliaceum

**GENERAL CHARACTERISTICS**

**ADVANTAGES**
- Can serve as forage
- Rapid growth
- Tolerates drought and heat
- Quickly adds soil organic matter

**DISADVANTAGES**
- Frost sensitive
- Seedlings are susceptible to slug herbivory

**WEED CONTROL**: good

**PEST CONTROL**: DU

**GROWTH FEATURES**

- **GERMINATION**: fast
- **GROWTH RATE**: high
- **FALLOW-PERIOD DURATION**: short to intermediate

**SOIL**

- **TYPE**: all
- **PREPARATION**: fine, packed seedbed
- **EFFECT ON STRUCTURE**: positive (extremely strong root system)

**SOWING**

<table>
<thead>
<tr>
<th>Period</th>
<th>Method</th>
<th>Depth</th>
<th>Rate</th>
<th>Cost (€/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Late April to late July</td>
<td>Broadcast sowing, pass with roller</td>
<td>1–2 cm</td>
<td>10 kg/ha*</td>
<td>✅✅✅✅</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>TKW = 5 g</td>
<td></td>
</tr>
</tbody>
</table>

**MIXTURES**: can be used with legumes (e.g., forage lentil, berseem clover, Persian clover)

**TERMINATION**

- **Freeze tolerance**: Sensitive
  - ≤ 0 to -1°C
  - Sensitivity depends on cover development stage

**MOST EFFECTIVE METHODS**

1. Crushing
2. Tilling

**PLACEMENT IN ROTATION**

- Anything, can come after barley
- **PROSO MILLET**: Spring legumes (e.g., pea, lentil, vetch), maize, sunflower, etc.
Italian ryegrass

*Lolium multiforum*

### General Characteristics

**Advantages**
- Can serve as forage
- Excellent, early growth

**Disadvantages**
- Biennial
- Host plant for aphids
- Can reduce water availability in soil if left in place too long
- Can flower or bolt if not terminated quickly enough

**Weed Control:** Intermediate

**Pest Control:** Encourages presence of the corn ground beetle

### Growth Features

**Germination:** Fast

**Growth Rate:** High

**Fallow-period Duration:** Short to intermediate

### Soil

**Type:** All

**Preparation:** Fine seedbed

**Effect on Structure:** Positive (dense fibrous root system)

### Sowing

<table>
<thead>
<tr>
<th>Period</th>
<th>Method</th>
<th>Depth</th>
<th>Rate</th>
<th>Cost (€/ha)</th>
</tr>
</thead>
</table>
| August to mid-October | Row sowing, Broadcast sowing, pass with roller | 1 cm max | 12–20 kg/ha | TKW = 3.5 g | 🍀🍀🍀🍀

**Mixtures:** Can be used with legumes (e.g., vetch, forage lentil)

### Termination

**Freeze Tolerance:** Hardy < -15°C

**Most Effective Methods**

1. Shredding
2. Tilling

### Placement in Rotation

- Avoid grasses
- **Italian Ryegrass**
- Spring legumes (e.g., pea, lentil, vetch), sunflower, etc.

**Written by:**
Adeline Cadillon (ITAB)

With assistance from:
M. Mangin (ARVALIS), S. Minette (Poitou-Charentes Chamber of Agriculture), J. Arino (Gers Chamber of Agriculture)
Italian ryegrass
Lolium multiforum

**PERSPECTIVES FROM THE FIELD**

JÉRÔME LABREUCHE, ARVALIS PLANT INSTITUTE

It is easy to establish but more complicated to terminate. Italian ryegrass is very risky to grain growers (has negative effects on the following cash crop, can enhance presence of weeds). Alternative varieties, with short life spans, establish themselves quickly but last no longer than 6 months.
Italian ryegrass
(alternative variety)
Lolium multiforum

**GENERAL CHARACTERISTICS**

**ADVANTAGES**
- Rapid growth
- Can be grown as a relay crop to produce forage

**DISADVANTAGES**
- Host plant for aphids

**WEED CONTROL:** intermediate (good soil cover)

**PEST CONTROL:** host plant for aphids

**GROWTH FEATURES**

**GERMINATION:** fast

**GROWTH RATE:** intermediate to high

**FALLOW-PERIOD DURATION:** short to intermediate

**SOIL**

**TYPE:** all

**PREPARATION:** fine seedbed

**EFFECT ON STRUCTURE:** positive (dense fibrous root system)

**SOWING**

<table>
<thead>
<tr>
<th>Period</th>
<th>Method</th>
<th>Depth</th>
<th>Rate</th>
<th>Cost (€/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>August to mid-Oct</td>
<td>Row sowing</td>
<td>2 cm</td>
<td>20 kg/ha TKW = 1.8 g</td>
<td>●●●○○</td>
</tr>
<tr>
<td></td>
<td>Broadcast sowing, pass with roller</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**MIXTURES:** can be used with legumes (e.g., vetch, forage lentil)

**TERMINATION**

**Freeze tolerance:**
- Sensitive ≤ -8°C

**MOST EFFECTIVE METHODS**
1. Shredding
2. Ploughing/tilling

**PLACEMENT IN ROTATION**

- Avoid grasses
- **ITALIAN RYEGRASS (ALT)**: Spring legumes (e.g., pea, lentil, vetch), maize, sunflower, etc.
Rye
Secale cerale

**General Characteristics**

**Advantages**
- Good soil cover
- No risk of flowering or bolting
- Positive effect on soil structure (0–25 cm)
- More disease resistant than barley or common oat

**Disadvantages**
- Host plant for aphids
- Late sowing date

**Weed Control:** good

**Pest Control:** DU

**Growth Features**

**Germination:** fast

**Growth Rate:** low to intermediate

**Fallow-period Duration:** long

**Soil**

**Type:** all; prefers acidic soils

**Preparation:** fine seedbed

**Effect on Structure:** positive (rather deep fibrous root system)

**Sowing**

<table>
<thead>
<tr>
<th>Period</th>
<th>Method</th>
<th>Depth</th>
<th>Rate</th>
<th>Cost (€/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>July to September</td>
<td>Row sowing</td>
<td>1–2 cm</td>
<td>25–80 kg/ha</td>
<td>✦✦✦✦</td>
</tr>
<tr>
<td></td>
<td>Broadcast sowing, pass with roller</td>
<td></td>
<td>TKW = 40–50 g</td>
<td>✔</td>
</tr>
</tbody>
</table>

**Mixtures:** can be used with legumes (e.g., pea, vetch, faba bean)

**Termination**

**Freeze Tolerance:**
Hardy < -15 °C

**Most Effective Methods**
1. Winter killing + crushing/shredding
2. Ploughing/tilling

**Placement in Rotation**

Avoid grasses

**Rye**

Spring legumes (e.g., pea, lentil, vetch), maize, sunflower, etc.

**D.U:** data unavailable
Rye
Secale cereale

Perspectives from the Field

Jérôme Labreuche, ARVALIS Plant Institute

Rye is a cold-tolerant grain that yields long-lasting cover. It is also relatively easy to establish. It is a little bit harder to terminate than other grains though. Slugs can cause damage to young plants.

September 2013
**General Characteristics**

**Advantages**
- Produces large amounts of biomass
- No risk of bolting
- Tolerates drought and heat
- Can serve as forage
- Very cold sensitive

**Disadvantages**
- Seedlings need long, warm days to grow
- Must be mature when used as forage (height > 70 cm; otherwise potential for cyanogenic glycoside poisoning) and cannot be consumed if freezes

** Weed Control:** intermediate to good  
** Pest Control:** poor, susceptible to wireworms

**Growth Features**

**Germination:** fast  
**Growth Rate:** high  
**Fallow-period Duration:** intermediate

**Soil**

**Type:** all  
**Preparation:** fine seedbed

**Sowing**

<table>
<thead>
<tr>
<th>Period</th>
<th>Method</th>
<th>Depth</th>
<th>Rate</th>
<th>Cost (€/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>July to September</td>
<td>Row sowing, Broadcast sowing, pass with roller</td>
<td>2 cm</td>
<td>15–25 kg/ha, TKW = 25–35 g</td>
<td>○○○○○</td>
</tr>
</tbody>
</table>

**Mixtures:** can be used with legumes (e.g., pea, vetch, berseem clover, Persian clover)

**Termination**

**Freeze Tolerance:** Sensitive ≤ 0 to -1°C  
Sensitivity depends on cover development stage

**Most Effective Methods**
1. Winter killing + crushing  
2. Tilling

**Placement in Rotation**

- Avoid grasses
- Sudan Grass
- Spring legumes (e.g., pea, lentil, vetch), sunflower, etc.
Sudan grass

*Sorghum sudanense*

**PERSPECTIVES FROM THE FIELD**

FRÉDÉRIC ARNAUD, MEURTHE AND MOSELLE CHAMBER OF AGRICULTURE

“In Lorraine, it is best to sow Sudan grass before July 10 if it is being used in the summer fallow period. Otherwise, it will not build enough biomass to provide effective cover.”
Winter barley
Hordeum vulgare

GENERAL CHARACTERISTICS

ADVANTAGES
Rather rapid seedling growth
Susceptible to spring diseases

DISADVANTAGES
Deals poorly with waterlogged and anoxic soils
Susceptible to barley yellow dwarf virus
Appeals to grey field slugs

Weed control: intermediate
Pest control: poor, encourages presence of the corn ground beetle

GROWTH FEATURES

GERMINATION: fast
GROWTH RATE: intermediate to high
FALLOW-PERIOD DURATION: intermediate

SOIL

TYPE: all
PREPARATION: no specific requirements
EFFECT ON STRUCTURE: positive (fibrous root system)

SOWING

<table>
<thead>
<tr>
<th>Period</th>
<th>Method</th>
<th>Depth</th>
<th>Rate</th>
<th>Cost (€/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>July to early</td>
<td>Row sowing</td>
<td>2–3 cm</td>
<td>80–100 kg/ha</td>
<td></td>
</tr>
<tr>
<td>September</td>
<td>Broadcast sowing, pass with</td>
<td></td>
<td>TKW = 40 to 50 g</td>
<td></td>
</tr>
<tr>
<td></td>
<td>roller</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MIXTURES: can be used with legumes (e.g., pea, vetch, clover)

TERMINATION

Freeze tolerance:
Hardy ≤ -8°C

MOST EFFECTIVE METHODS
1. Shredding
2. Ploughing/tilling

Placement in rotation

Late-harvest crops: maize, forage brassicas
Avoid grasses

Winter Barley

Spring legumes (e.g., pea, lentil, vetch), maize, sunflower, etc.
Camelina
Cameline sativa

GENERAL CHARACTERISTICS

ADVANTAGES
Hardy
Strong allelopathic activity (suppressive effect)
Positive effect on soil structure
Strong growth

DISADVANTAGES
Drought intolerant during early development
Risk of bolting if sown too early

WEED CONTROL: intermediate to good
PEST CONTROL: DU

GROWTH FEATURES

GERMINATION: fast
GROWTH RATE: high
FALLOW-PERIOD DURATION: long

SOIL

TYPE: all
PREPARATION: fine seedbed
EFFECT ON STRUCTURE: positive (taproot)

SOWING

<table>
<thead>
<tr>
<th>Period</th>
<th>Method</th>
<th>Depth</th>
<th>Rate</th>
<th>Cost (€/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>July to late September</td>
<td>Broadcast sowing, pass with roller</td>
<td>1 cm max</td>
<td>2–5 kg/ha TKW = 1.5–2 g</td>
<td>⬜⬜⬜⬜⬜</td>
</tr>
</tbody>
</table>

MIXTURES: can be used with spring grains or other spring crops (pea, buckwheat)

TERMINATION

Freeze tolerance: Sensitive to hardy ≤ -10°C

MOST EFFECTIVE METHODS
1. Shredding
2. Tilling

Placement in rotation:

Anything
Avoid sunflower and rapeseed

Camelina
Avoid rapeseed and maize

Anything
Camelina
Cameline sativa

**PERSPECTIVES FROM THE FIELD**

SÉBASTIEN MINETTE, PROJECT LEADER, POITOU-CHARENTES CHAMBER OF AGRICULTURE

“It provides excellent cover, similar to that of mustard, but produces less biomass. Sowing is simple, and the plant germinates easily. Camelina displays strong allelopathic activity towards other plants, which means it does not work well in mixtures. Watch out for bolting! Do not sow too early, and be sure to terminate quickly, in mid-November or mid-December by the latest.”

JÉRÔME LABREUCHE, ARVALIS PLANT INSTITUTE

“This brassica is one of the latest intermediate crops to be commercialised. It produces less biomass than other brassicas (e.g., mustard, radish). Its growth cycle is very short. Consequently, if it is sown early, it is important to terminate it before it bolts.”
Winter rapeseed
Brassica napus

**GENERAL CHARACTERISTICS**

**ADVANTAGES**
- Provides good cover
- Produces large quantities of biomass
- Late flowering

**DISADVANTAGES**
- Intolerant of water stress
- At significant risk of parasitism and disease
- Difficult to terminate and fully prevent regrowth

**WEED CONTROL:** good

**PEST CONTROL:** DU

**GROWTH FEATURES**

**GERMINATION:** fast

**GROWTH RATE:** good

**FALLOW-PERIOD DURATION:** intermediate

**SOIL**

**TYPE:** all

**PREPARATION:** fine seedbed

**EFFECT ON STRUCTURE:** positive (taproot)

**SOWING**

<table>
<thead>
<tr>
<th>Period</th>
<th>Method</th>
<th>Depth</th>
<th>Rate</th>
<th>Cost (€/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>August to</td>
<td>Broadcast sowing, pass</td>
<td>1 cm</td>
<td>8 kg/ha</td>
<td>● 0 0 0</td>
</tr>
<tr>
<td>September</td>
<td>with roller</td>
<td></td>
<td>TKW = 6 g</td>
<td></td>
</tr>
</tbody>
</table>

**MIXTURES:** can be used with legumes (e.g., vetch, pea, faba bean) or grasses (ryegrass)

**TERMINATION**

**Freeze tolerance:**
- Hardy < -15°C

**Sensitivity depends on cover development stage**

**MOST EFFECTIVE METHODS**

1. Shredding
2. Tilling

**PLACEMENT IN ROTATION**

- Anything
  - Avoid use in rotations with rapeseed
- **WINTER RAPSEED**
  - Avoid sunflower, maize; avoid use in rotations with
- Anything
**Forage rapeseed**

*Brassica napus*

### General Characteristics

**Advantages**
- Strong growth
- Good soil cover
- Can serve as forage
- Late flowering

**Disadvantages**
- At significant risk of parasitism and disease
- Difficult to terminate and fully prevent regrowth

**Weed control:** Good

**Pest control:** DU

### Growth Features

**Germination:** Fast

**Growth rate:** High

**Fallow-period duration:** Short

### Soil

**Type:** All

**Preparation:** Fine seedbed

**Effect on structure:** Positive (strong taproot system)

### Sowing

<table>
<thead>
<tr>
<th>Period</th>
<th>Method</th>
<th>Depth</th>
<th>Rate</th>
<th>Cost (€/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before late August</td>
<td>Row sowing</td>
<td>1 cm</td>
<td>5–8 kg/ha</td>
<td>TKW = 3.5–7 g</td>
</tr>
<tr>
<td>or early September</td>
<td>Broadcast sowing, pass with roller</td>
<td></td>
<td>TKW = 3.5–7 g</td>
<td></td>
</tr>
</tbody>
</table>

**Mixtures:** Can be used with legumes (e.g., vetch, pea, faba bean) or grasses (ryegrass)

### Termination

**Freeze tolerance:** Hardy < -15°C

**Most effective methods**

1. Shredding (in the month after flowering)
2. Tilling

**Placement in rotation**

- **Anything**
  - Avoid use in rotations with rapeseed

- **Winter forage rapeseed**
  - Avoid sunflower, beet; avoid use in rotations with rapeseed

**DU:** Data unavailable

---

Written by: Adeline Cadillon (ITAB)

With assistance from: M. Mangin (ARVALIS), J. Arino (Gers Chamber of Agriculture)

**Sensitivity depends on cover development stage**

---

**To obtain proper cover development**

**Rapeseed regrowth** can be used as a cover crop.
Rapeseed regrowth serves as a good catch crop. Rapeseed varieties, whether for oilseed or forage production, can be used as intermediate crops or as relay forage crops.
**White mustard**

*Sinapis alba*

### General Characteristics

#### Advantages
- Easy and fast to establish
- Positive effect on soil structure
- Highly tolerant of warm, dry conditions
- Mobilises phosphorus

#### Disadvantages
- Flowers rapidly (50–60 days) and thus risk of bolting
- Intolerant of water stress (and nitrogen scarcity); speeds up time to bolting

#### Weed control: good

#### Pest control: susceptible to pests such as sawflies (larvae), grain weevils, and flea beetles.

### Growth Features

**Germination:** fast

**Growth rate:** high

**Fallow-period duration:** short

### Soil

**Type:** all

**Preparation:** stubble ploughing

**Effect on structure:** positive (taproot)

### Sowing

<table>
<thead>
<tr>
<th>Period</th>
<th>Method</th>
<th>Depth</th>
<th>Rate</th>
<th>Cost (€/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>July to September</td>
<td>Broadcast sowing, pass with roller</td>
<td>1 cm</td>
<td>8–10 kg/ha</td>
<td>1100</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>TKW = 6–8 g</td>
<td></td>
</tr>
</tbody>
</table>

**Mixtures:** can be used with legumes (e.g., crimson clover, lentil, vetch) or grasses

### Termination

**Freeze tolerance:** Sensitive ≤ -7°C

**Most effective methods**
- Winter killing + crushing
- Shredding

**Anti-beet nematode** variety of white mustard: €2.50/kg

### Placement in Rotation

**Anything**
- Avoid use in rotations with rapeseed and sunflower

**White mustard**
- Avoid brassicas (rapeseed, beet), sunflower, and maize

**Anything**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

DU: data unavailable
White mustard

Sinapis alba

**PERSPECTIVES FROM THE FIELD**

FRÉDÉRIC ARNAUD, MEURTHE AND MOSELLE CHAMBER OF AGRICULTURE

“White mustard cover can either have amazing benefits or catastrophic effects! It can be sown until late in the year. Vegetative growth is extremely rapid. It is a good indicator of soil function because it is sensitive to compaction and nitrogen levels.”

SÉBASTIEN MINETTE, PROJECT LEADER, POITOU-CHARENTES CHAMBER OF AGRICULTURE

“It is easy to sow and comes up without a problem. It is the simplest cover crop species to use! It produces large amounts of biomass. It suppresses weeds and has a positive effect on soil structure. If white mustard is sown too early (August 15 to September 15), there is a risk of bolting. The cover must be terminated when it flowers. When it is included in mixtures, it competes with legumes, unless the sowing rate has been adapted.”

JÉRÔME LABREUCHE, ARVALIS PLANT INSTITUTE

“White mustard has trouble with water stress and heat when it is sown too early. It is easy to establish and terminate. If the cover is well developed, it will be difficult to plough under. It must be shredded, or first flattened by replacing the jointer with a taut chain. Its ease of establishment is an advantage. It is a good cover crop for breaking up grain-based rotations. It is not recommended for use in rapeseed-heavy rotations.”
**Brown mustard**  
*Brassica juncea*

### General Characteristics

**Advantages**  
- Strong allelopathic activity targeting certain fungi and parasites  
- Helps control certain grain diseases  
- Better growth and nitrogen uptake than white mustard

**Disadvantages**  
- Flowers rapidly (50–60 days) and thus risk of bolting  
- Few varieties available

**Weed Control:** good (suppressive effect)  
**Pest Control:** good (e.g., take-all disease, root rot [*Rhizoctonia solani*], Fusarium wilt)

### Growth Features

**Germination:** fast  
**Growth Rate:** high  
**Fallow-Period Duration:** short

### Soil

**Type:** all  
**Preparation:** stubble ploughing  
**Effect on Structure:** positive (taproot)

### Sowing

<table>
<thead>
<tr>
<th>Period</th>
<th>Method</th>
<th>Depth</th>
<th>Rate</th>
<th>Cost (€/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>July to early September</td>
<td>Broadcast sowing, pass with roller</td>
<td>1 cm</td>
<td>3–4 kg/ha TKW = 3 g</td>
<td>☢☢☢☢</td>
</tr>
</tbody>
</table>

**Mixtures:** can be used with legumes (e.g., crimson clover, lentil, vetch) or grasses

### Termination

**Freeze Tolerance:** Sensitive  
≤ -5 to -10°C  
**Sensitivity depends on cover development stage**

**Most Effective Methods**  
1. Winter killing + crushing/shredding  
2. Ploughing

### Placement in Rotation

- **Anything**  
  - Avoid use in rotations with brassicas or sunflower  
- **Brown Mustard**  
  - Avoid brassicas (rapeseed, beet), sunflower, and maize  
- **Anything**
The TKW of brown mustard is much lower than that of white mustard. The species can be sown until late in the year. Vegetative growth is extremely rapid. It is a good indicator of soil function because it is sensitive to compaction and nitrogen levels.

Because brown mustard has higher glucosinolate levels than other brassicas, it may have stronger allelopathic effects on certain fungi, such as take-all disease in wheat on wheat rotations or *Rhizoctonia solani*. It produces a bit more biomass than white mustard.
Winter turnip rape
Brassica rapa oleifera

**General characteristics**

**Advantages**
- Does not flower in winter
- Helps control certain grain diseases
- Can be used to produce forage
- Very similar to forage rapeseed

**Disadvantages**
- Tricky to terminate if taproot is well developed
- Sensitive to water stress, which provokes flowering
- Risk of bolting after a freeze

**Weed control:** good (suppressive effect)

**Pest control:** DU

**Growth features**

**Germination:** fast

**Growth rate:** high

**Fallow-period duration:** short

**Soil**

**Type:** all

**Preparation:** stubble ploughing and establishment of fine seedbed

**Effect on structure:** positive (taproot)

**Sowing**

<table>
<thead>
<tr>
<th>Period</th>
<th>Method</th>
<th>Depth</th>
<th>Rate</th>
<th>Cost (€/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>August-September</td>
<td>Broadcast sowing, pass with roller</td>
<td>2 cm</td>
<td>5–8 kg/ha TKW = 4–6 g</td>
<td>⚫⚫⚫⚫⚫</td>
</tr>
</tbody>
</table>

**Mixtures:** Plant as single-species cover crop or with a legume (e.g., vetch, pea)

**Termination**

**Freeze tolerance:**
- Sensitive
- ≤ -8 to -10°C

**Most effective methods**
1. Shredding
2. Ploughing/tilling

**Placement in rotation**

- Avoid sunflower, maize, beet; avoid use in rotations with rapeseed

**Written by:**
Adeline Codillon (ITAB)

**With assistance from:**
M. Mangin (ARVALIS)
**Winter turnip rape**

*Brassica rapa oleifera*

---

**PERSPECTIVES FROM THE FIELD**

**Sébastien Minette, Project leader, Poitou-Charentes Chamber of Agriculture**

"Turnip rape starts as a rosette of leaves close to the ground. It can be tricky to terminate, especially via shredding, but its cover is among the most extensive. This species is often used as part of a mixture, sown after a grain-legume crop. Compared to mustard, it has a greater impact on soil structure."

**Jérôme Labreuche, ARVALIS Plant Institute**

"This species has the benefit of rarely flowering before the winter (if the winter variety is used), even when it is sown early. This brassica is easy to establish but more difficult to terminate."
Forage radish
*Raphanus sativus*

**Brassicas**

**GENERAL CHARACTERISTICS**

**ADVANTAGES**
- Rapid growth
- Can serve as forage

**DISADVANTAGES**
- Termination is very tricky if the taproot is well developed (the vestige of the root can reinitiate growth)
- Requires high levels of nitrogen
- Risk of bolting
- Very cold tolerant

**WEED CONTROL:** good (suppressive effect)

**PEST CONTROL:** anti-nematode varieties exist

**GROWTH FEATURES**

**GERMINATION:** fast

**GROWTH RATE:** high

**FALLOW-PERIOD DURATION:** intermediate

**SOIL**

**TYPE:** all

**PREPARATION:** stubble ploughing and establishment of fine seedbed

**EFFECT ON STRUCTURE:** positive (taproot)

**SOWING**

<table>
<thead>
<tr>
<th>Period</th>
<th>Method</th>
<th>Depth</th>
<th>Rate</th>
<th>Cost (€/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>July-August</td>
<td>Row sowing</td>
<td>1–2 cm</td>
<td>8–12 kg/ha</td>
<td>⬠⬤⬤⬤⬤</td>
</tr>
<tr>
<td></td>
<td>Broadcast sowing, pass with roller</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**MIXTURES:** radish growth (cover and biomass) can be enhanced by either a legume or a vetch (e.g., provide nitrogen)

**TERMINATION**

**Freeze tolerance:**
Hardy < -15°C

**Sensitivity depends on cover development stage**

**MOST EFFECTIVE METHODS**
1. Shredding
2. Ploughing

**PLACE IN ROTATION**

Avoid use in rotations with brassicas

Avoid use in rotations with brassicas (rapeseed, beet)
Forage radish
Raphanus sativus

PERSPECTIVES FROM THE FIELD

FRÉDÉRIC ARNAUD, MEURTHE AND MOSELLE CHAMBER OF AGRICULTURE

“This cover crop needs lots of nitrogen and grows very rapidly. It is one of a few species to strongly restructure the soil.”

SÉBASTIEN MINETTE, PROJECT LEADER, POITOU-CHARENTES CHAMBER OF AGRICULTURE

“The forage radish is a brassica and thus shares certain characteristics with mustard. However, it produces a bit less biomass. It is often used as part of a mixture, sown after a grain-legume crop.”

JÉRÔME LABREUCHE, ARVALIS PLANT INSTITUTE

“Forage radish is less sensitive to water stress than mustard is. It is also better suited to early sowing. Farmers like this species because it is easy to establish and it grows fast. It is rather hard to terminate mechanically, but the process can be facilitated by winter killing, notably when plants are well-developed.”
Nyger
Guizotia abyssinica

**GENERAL CHARACTERISTICS**

**ADVANTAGES**
- Heat and drought tolerant
- Very cold sensitive
- Flowers relatively late
- Strong growth
- Positive effect on soil structure

**DISADVANTAGES**
- Allelopathic activity directed towards other plants (produces compound that inhibits germination of seeds other than its own)
- Strongly appeals to slugs
- Provides limited soil cover (erect growth form)
- Requires high accumulated temperatures

**WEED CONTROL:** intermediate

**PEST CONTROL:** DU

**GROWTH FEATURES**

**GERMINATION:** fast

**GROWTH RATE:** intermediate

**FALLOW-PERIOD DURATION:** short

**SOIL**

**TYPE:** all

**PREPARATION:** no specific requirements

**EFFECT ON STRUCTURE:** positive (taproot)

**SOWING**

<table>
<thead>
<tr>
<th>Period</th>
<th>Method</th>
<th>Depth</th>
<th>Rate</th>
<th>Cost (€/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>July-August</td>
<td>Broadcast sowing, pass with roller</td>
<td>1 cm</td>
<td>8–10 kg/ha</td>
<td>⬜⬜⬜⬜ouis</td>
</tr>
</tbody>
</table>

**MIXTURES:** not recommended for use in mixtures (allelopathic activity)

**TERMINATION**

**Freeze tolerance:**
- Very sensitive
- ≤ 0°C

**MOST EFFECTIVE METHODS**
1. Winter killing + crushing
2. Shredding/ploughing

**PLACEMENT IN ROTATION**

Anything
Avoid using in rotations with sunflower

NYGER

Anything
Avoid using in rotations with sunflower

DU: data unavailable
Nyger

Guizota abyssinica

**PERSPECTIVES FROM THE FIELD**

**FRÉDÉRIC ARNAUD, MEURTHE AND MOSELLE CHAMBER OF AGRICULTURE**

“Nyger is difficult to establish. It is also susceptible to slug damage.”

**SÉBASTIEN MINETTE, PROJECT LEADER, POITOU-CHARENTE CHAMBER OF AGRICULTURE**

“Nyger is difficult to establish. It is also susceptible to slug damage. It is drought resistant but very frost sensitive. It has small seeds that are easy to plant. Cover development varies greatly from year to year. However, it can be useful in mixtures.”

**JÉRÔME LABREUCHE, ARVALIS PLANT INSTITUTE**

“Nyger shows strong growth if established early. However, getting it going can be complicated. Its temperature needs and extreme frost sensitivity—it should be terminated after the first freeze—are the reasons why nyger frequently fails when sown late. Its high degree of frost sensitivity is an advantage, even if its regrowth shows limited competitive ability. Nyger also seems to appeal to slugs.”
Sunflower
Helianthus annuus

**General characteristics**

**Advantages**
- Heat and drought tolerant
- Hardy
- Good soil cover
- Helpful in mixtures (good companion crop)
- Late flowering (depending on variety)

**Disadvantages**
- Strongly appeals to slugs
- Cold sensitive
- Strict temperature requirements

**Weed control:** poor to intermediate

**Pest control:** DU

**Growth features**

**Germination:** intermediate

**Growth rate:** high

**Fallow-period duration:** short

**Soil**

**Type:** all

**Preparation:** no specific requirements

**Effect on structure:** positive (deep taproot)

**Sowing**

<table>
<thead>
<tr>
<th>Period</th>
<th>Method</th>
<th>Depth</th>
<th>Rate</th>
<th>Cost (€/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>August</td>
<td>Broadcast sowing, pass with roller</td>
<td>2–3 cm</td>
<td>40 kg/ha</td>
<td>TKW = 40–55 g</td>
</tr>
</tbody>
</table>

**Mixtures:** can be used with oat, pea, lentil, etc.

**Termination**

**Freeze tolerance:** Sensitive ≤ 0 to -2°C

**Most effective methods**
1. Winter killing + crushing
2. Shredding/ploughing

**Placement in rotation**

- Anything
  - Avoid using in rotations with sunflower or Sclerotinia host species

- **SUNFLOWER**
  - Avoid using in rotations with brassicas, sunflower, or Sclerotinia host species

**Weed control:** poor to intermediate

**Pest control:** DU

**Effect on structure:** positive (deep taproot)

**Sowing**

<table>
<thead>
<tr>
<th>Period</th>
<th>Method</th>
<th>Depth</th>
<th>Rate</th>
<th>Cost (€/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>August</td>
<td>Broadcast sowing, pass with roller</td>
<td>2–3 cm</td>
<td>40 kg/ha</td>
<td>TKW = 40–55 g</td>
</tr>
</tbody>
</table>

**Mixtures:** can be used with oat, pea, lentil, etc.

**Termination**

**Freeze tolerance:** Sensitive ≤ 0 to -2°C

**Most effective methods**
1. Winter killing + crushing
2. Shredding/ploughing

**Placement in rotation**

- Anything
  - Avoid using in rotations with sunflower or Sclerotinia host species

- **SUNFLOWER**
  - Avoid using in rotations with brassicas, sunflower, or Sclerotinia host species

**Weed control:** poor to intermediate

**Pest control:** DU

**Effect on structure:** positive (deep taproot)

**Sowing**

<table>
<thead>
<tr>
<th>Period</th>
<th>Method</th>
<th>Depth</th>
<th>Rate</th>
<th>Cost (€/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>August</td>
<td>Broadcast sowing, pass with roller</td>
<td>2–3 cm</td>
<td>40 kg/ha</td>
<td>TKW = 40–55 g</td>
</tr>
</tbody>
</table>

**Mixtures:** can be used with oat, pea, lentil, etc.

**Termination**

**Freeze tolerance:** Sensitive ≤ 0 to -2°C

**Most effective methods**
1. Winter killing + crushing
2. Shredding/ploughing

**Placement in rotation**

- Anything
  - Avoid using in rotations with sunflower or Sclerotinia host species

- **SUNFLOWER**
  - Avoid using in rotations with brassicas, sunflower, or Sclerotinia host species

**Weed control:** poor to intermediate

**Pest control:** DU

**Effect on structure:** positive (deep taproot)

**Sowing**

<table>
<thead>
<tr>
<th>Period</th>
<th>Method</th>
<th>Depth</th>
<th>Rate</th>
<th>Cost (€/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>August</td>
<td>Broadcast sowing, pass with roller</td>
<td>2–3 cm</td>
<td>40 kg/ha</td>
<td>TKW = 40–55 g</td>
</tr>
</tbody>
</table>

**Mixtures:** can be used with oat, pea, lentil, etc.

**Termination**

**Freeze tolerance:** Sensitive ≤ 0 to -2°C

**Most effective methods**
1. Winter killing + crushing
2. Shredding/ploughing

**Placement in rotation**

- Anything
  - Avoid using in rotations with sunflower or Sclerotinia host species

- **SUNFLOWER**
  - Avoid using in rotations with brassicas, sunflower, or Sclerotinia host species

**Weed control:** poor to intermediate

**Pest control:** DU

**Effect on structure:** positive (deep taproot)

**Sowing**

<table>
<thead>
<tr>
<th>Period</th>
<th>Method</th>
<th>Depth</th>
<th>Rate</th>
<th>Cost (€/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>August</td>
<td>Broadcast sowing, pass with roller</td>
<td>2–3 cm</td>
<td>40 kg/ha</td>
<td>TKW = 40–55 g</td>
</tr>
</tbody>
</table>

**Mixtures:** can be used with oat, pea, lentil, etc.

**Termination**

**Freeze tolerance:** Sensitive ≤ 0 to -2°C

**Most effective methods**
1. Winter killing + crushing
2. Shredding/ploughing

**Placement in rotation**

- Anything
  - Avoid using in rotations with sunflower or Sclerotinia host species

- **SUNFLOWER**
  - Avoid using in rotations with brassicas, sunflower, or Sclerotinia host species

**Weed control:** poor to intermediate

**Pest control:** DU

**Effect on structure:** positive (deep taproot)

**Sowing**

<table>
<thead>
<tr>
<th>Period</th>
<th>Method</th>
<th>Depth</th>
<th>Rate</th>
<th>Cost (€/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>August</td>
<td>Broadcast sowing, pass with roller</td>
<td>2–3 cm</td>
<td>40 kg/ha</td>
<td>TKW = 40–55 g</td>
</tr>
</tbody>
</table>

**Mixtures:** can be used with oat, pea, lentil, etc.

**Termination**

**Freeze tolerance:** Sensitive ≤ 0 to -2°C

**Most effective methods**
1. Winter killing + crushing
2. Shredding/ploughing

**Placement in rotation**

- Anything
  - Avoid using in rotations with sunflower or Sclerotinia host species

- **SUNFLOWER**
  - Avoid using in rotations with brassicas, sunflower, or Sclerotinia host species

**Weed control:** poor to intermediate

**Pest control:** DU

**Effect on structure:** positive (deep taproot)

**Sowing**

<table>
<thead>
<tr>
<th>Period</th>
<th>Method</th>
<th>Depth</th>
<th>Rate</th>
<th>Cost (€/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>August</td>
<td>Broadcast sowing, pass with roller</td>
<td>2–3 cm</td>
<td>40 kg/ha</td>
<td>TKW = 40–55 g</td>
</tr>
</tbody>
</table>

**Mixtures:** can be used with oat, pea, lentil, etc.

**Termination**

**Freeze tolerance:** Sensitive ≤ 0 to -2°C

**Most effective methods**
1. Winter killing + crushing
2. Shredding/ploughing

**Placement in rotation**

- Anything
  - Avoid using in rotations with sunflower or Sclerotinia host species

- **SUNFLOWER**
  - Avoid using in rotations with brassicas, sunflower, or Sclerotinia host species

**Weed control:** poor to intermediate

**Pest control:** DU

**Effect on structure:** positive (deep taproot)

**Sowing**

<table>
<thead>
<tr>
<th>Period</th>
<th>Method</th>
<th>Depth</th>
<th>Rate</th>
<th>Cost (€/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>August</td>
<td>Broadcast sowing, pass with roller</td>
<td>2–3 cm</td>
<td>40 kg/ha</td>
<td>TKW = 40–55 g</td>
</tr>
</tbody>
</table>

**Mixtures:** can be used with oat, pea, lentil, etc.
**Perspectives from the Field**

**Frédéric Arnaud, Meurthe and Moselle Chamber of Agriculture**

“Sunflower can be very useful in mixtures. It will be the tallest plant of the group. It has a taproot, which improves soil structure. It can also be used as a single-species cover crop and will produce abundant biomass. However, it should not be planted before a grain.”

**Sébastien Minette, Project Leader, Poitou-Charentes Chamber of Agriculture**

“Sunflower seeds need to be planted deep into the soil to ensure rapid growth and to limit bird predation. It is a drought tolerant species, and its taproot can come in handy. It should not be used in rotations with sunflower.”

**Jérôme Labreuche, Arvalis Plant Institute**

“In the summer, sunflower develops well when sown early. It is very frost sensitive, which makes it easier to terminate. However, that same trait makes late sowing problematic. It should not be used as a fallow-period cover crop in fields in which sunflower is farmed for commercial purposes because of disease risks (Phoma black stem, mildew, Phomopsis stem canker).”

**David Hypolite, Farmer in Meurthe and Moselle**

“The sunflower’s root system extends down deep, and I use the species as a companion crop in the oat-vetch-sunflower mixture that I plant before my grass cash crops.”
Blue tansy
Phacelia tanacetifolia

**GENERAL CHARACTERISTICS**

**ADVANTAGES**
Rapid development (flowering after two months; bolting after three months)
Comes from a rarely cultivated taxonomic family; provides a true break in the rotation
Positive effect on soil structure

**WEED CONTROL:** good (suppressive effect)
**PEST CONTROL:** repels flea beetles and aphids

**DISADVANTAGES**
Necessary to prevent bolting; can lead to resowing
Sowing can be tricky

**GROWTH FEATURES**

**GERMINATION:** slow
**GROWTH RATE:** high
**FALLOW-PERIOD DURATION:** intermediate

**SOIL**
**TYPE:** all
**PREPARATION:** fine seedbed
**EFFECT ON STRUCTURE:** positive (intermediate system—taproot and fibrous roots)

**SOIL**
**TYPE:** all
**PREPARATION:** fine seedbed
**EFFECT ON STRUCTURE:** positive (intermediate system—taproot and fibrous roots)

**SOWING**

<table>
<thead>
<tr>
<th>Period</th>
<th>Method</th>
<th>Depth</th>
<th>Rate</th>
<th>Cost (€/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>July-August</td>
<td>Row sowing</td>
<td>2–3 cm</td>
<td>8–12 kg/ha</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Broadcast sowing possible—covers ground well</td>
<td></td>
<td>TKW = 1.8 g</td>
<td></td>
</tr>
</tbody>
</table>

**MIXTURES:** can be used with buckwheat, for example

**TERMINATION**

**Freeze tolerance:**
Sensitive
≤ -7 to -10°C

**MOST EFFECTIVE METHODS**
1. Ploughing
2. Shredding/winter killing + crushing

**PLACEMENT IN ROTATION**

- **Blue tansy**
  - Avoid brassicas, sunflower, and soybean

- **Anything**
  - Avoid brassicas, sunflower, and soybean

**DU:** data unavailable

Written by: Adeline Cadillon (ITAB)
With assistance from: M. Mangin (ARVALIS), J. Bayle (Meurthe and Moselle Chamber of Agriculture)

September 2013
Blue tansy
Phacelia tanacetifolia

PERSPECTIVES FROM THE FIELD

FRÉDÉRIC ARNAUD, MEURTHE AND MOSELLE CHAMBER OF AGRICULTURE

Blue tansy is a great cover crop for breaking up the rotation. If you sow carefully, biomass levels should be good. It should also have a highly suppressive effect on weeds. Additionally, blue tansy appeals to bees.

SÉBASTIEN MINETTE, PROJECT LEADER, POITOU-CHARENTES CHAMBER OF AGRICULTURE

Blue tansy has an intermediate root system, with both a taproot and fibrous roots, which really improves soil structure. Make sure that the seeds are well covered during the sowing process. You want to ensure that seedling emergence is homogeneous and maximised. It provides great cover and attracts pollinators. It can be used to break the cycle of certain diseases and insects because it comes from a family of non-crops and is not very susceptible to pests. One disadvantage is the cost of its seeds, but it is a helpful addition to mixtures. Watch out for bolting if it is sown too early.

JÉRÔME LABREUCHE, ARVALIS PLANT INSTITUTE

This plant is tricky to establish. It needs fine soils to maximise the level of seed-soil contact. It is a useful species because it grows fast and provides good soil cover. Blue tansy is a member of the waterleaf family. Generally, it can fit in any type of rotation, although it should not be used before vegetable crops destined for commercial canning (industry concerns over Sclerotinia risk).
Buckwheat
Fagopyrum esculentum

**GENERAL CHARACTERISTICS**

**ADVANTAGES**
- Rapid development
- Tolerant of late-summer drought
- Allelopathic activity
- Comes from a rarely cultivated taxonomic family; provides a true break in the rotation

**DISADVANTAGES**
- Average level of soil cover
- Risk of (rapid) flowering and bolting

**WEED CONTROL:** intermediate

**PEST CONTROL:** DU

**GROWTH FEATURES**

**GERMINATION:** intermediate

**GROWTH RATE:** good

**FALLOW-PERIOD DURATION:** short to intermediate

**SOIL**

**TYPE:** all

**PREPARATION:** stubble ploughing and establishment of fine seedbed

**EFFECT ON STRUCTURE:** positive (taproot)

**SOWING**

<table>
<thead>
<tr>
<th>Period</th>
<th>Method</th>
<th>Depth</th>
<th>Rate</th>
<th>Cost (€/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right after harvest</td>
<td>Broadcast sowing, pass with</td>
<td>2–3 cm</td>
<td>30–40 kg/ha</td>
<td><strong>☆☆☆☆</strong></td>
</tr>
<tr>
<td>until mid-September</td>
<td>roller</td>
<td></td>
<td>TKW = 20–30 g</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Row sowing possible</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**MIXTURES:** can be used with mustard, blue tansy, and legumes

**FREEZE TOLERANCE:**
- Sensitive ≤ -2°C

**Sensitivity depends on cover development stage**

**MOST EFFECTIVE METHODS**
1. Winter killing + crushing
2. Shredding/ploughing

**TERMINATION**

**PLACEMENT IN ROTATION**

Anything  | **BUCKWHEAT**  | Anything

DU: data unavailable
Buckwheat is a good cover crop that allows a break in the rotation. However, it is a sensitive plant, and weeds can emerge when buckwheat is planted on its own. It is easy to terminate because it is very frost sensitive. It should always be used as part of a mixture.

This species absolutely needs to be established in early summer to allow time for proper development. Buckwheat is sometimes planted to produce a second harvest. It bolts rather easily and can become a weed in the following cash crop (it is a knotweed).
**Linseed**  
*Linum usitatissimum*  

---

**GENERAL CHARACTERISTICS**

**ADVANTAGES**  
- Tolerant of late-summer drought  
- Easy to terminate  
- From a rarely cultivated taxonomic family

**DISADVANTAGES**  
- Woody stems will be difficult to shred and take time to decompose if plant is well developed  
- Limited soil cover

**WEED CONTROL:** poor

**PEST CONTROL:** effects on rapeseed broomrape and the Colorado potato beetle remain to be quantified

---

**GROWTH FEATURES**

**GERMINATION:** fast  
**GROWTH RATE:** intermediate  
**FALLOW-PERIOD DURATION:** intermediate

**SOIL**

**TYPE:** all

**PREPARATION:** fine, packed seedbed  
**EFFECT ON STRUCTURE:** positive (deep taproot)

---

**SOWING**

<table>
<thead>
<tr>
<th>Period</th>
<th>Technique</th>
<th>Depth</th>
<th>Rate</th>
<th>Cost (€/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>mid-July to mid-August</td>
<td>Broadcast sowing, pass with roller</td>
<td>1 cm</td>
<td>20–50 kg/ha TKW = 4–7 g</td>
<td>🟢🟢🟢🟢</td>
</tr>
</tbody>
</table>

**MIXTURES:** can be used with legumes, grasses, brassicas, etc.

---

**TERMINATION**

**Freeze tolerance:**  
- Hardy (winter variety) ≤ -7 to -13°C  
- Sensitive (spring variety) < 0°C

**MOST EFFECTIVE METHODS**

1. Winter killing + crushing  
2. Shredding/ploughing

---

**PLACEMENT IN ROTATION**

*WINTER AND SPRING*

**Avoid linseed**

---

**SEPTEMBER 2013**

Written by:  
Adeline Cadillon  
(ITAB)

With assistance from:  
J. Champion (Drôme Chamber of Agriculture), J. Arino  
(Gers Chamber of Agriculture)
Linseed is sometimes included in certain cover crop mixtures. Its use as a stand-alone intermediate crop is less common, but it appears to develop just fine in such situations. However, if linseed is allowed to grow for too long, its stems become woody. They can interfere with the use of certain farm machinery and have trouble decomposing.
**Final Thoughts from the Experts**

- **Legumes** should not be used when nitrogen availability is high (e.g., significant organic amendment). However, they are indispensable when nitrogen is lacking.

- **Sowing techniques** vary and should be chosen based on the farming equipment available. Although any technique can be used, efficacy will vary. The most common and straightforward technique for sowing cover crops is broadcast sowing.

---

**Additional References**

- Agr’seau 26 Objectifs, no. 61 (2010). 100 % de couverture du sol en hiver, une obligation en zone vulnérable.

---

With assistance from the national working group on cover crops, managed by ITAB and the technical network for organic agriculture, composed of experts from various regional chambers of agriculture.

**Contributions and editing by:** Michel Mangin (ARVALIS Plant Institute), Sébastien Minette (Poitou-Charentes Chamber of Agriculture), Loïc Prieur (CREAB), Philippe Guichard (farmer), Florian Célette (ISARA-Lyon), Vincent Lefèvre (ISARA-Lyon), Marc Pottier (CORAB), Justin Bayle (Maurthe and Moselle Chamber of Agriculture), Gilles Salitot (Picardie Chamber of Agriculture), Jean Champion (Drôme Chamber of Agriculture), Pierre Gayraud (plant breeder), Patrice Ménétrier (Indre and Loire Chamber of Agriculture), Charlotte Glachant (Seine and Marne Chamber of Agriculture), Alain Lecat (Nord Chamber of Agriculture), Frédéric Arnaud (Maurthe and Moselle Chamber of Agriculture), Jean Arino (Gers Chamber of Agriculture)

[Logo: Institut Technique de l’Agriculture Biologique]