

Cover crops in medicinal and aromatic plant production

Benefits and implementation

Cover cropping is an important practice in organic farming. By producing additional biomass between two main crops, it improves fertility, structure and health of the soil and prevents erosion. Cover cropping is in line with organic farming principles which aim to conserve natural resources. It is also one of the main actions farmers can take to make their soils more resilient to climate change.

The guide provides an overview of the benefits and challenges of cover crop cultivation and gives practical guidance on species selection.



Benefits of cover crops

Cover crops can provide many benefits to crop rotations in medicinal and aromatic plant (MAP) cultivation.



Nutrient supply for main crops

- Cover crops enrich the topsoil by drawing plant nutrients from deeper layers of the soil.
- Leguminous cover crops add nitrogen from the atmosphere to the soil, reducing the need for commercial fertilisers.
- Root exudates feed the soil organisms, stimulating microbiological activity in the root zone. This again improves soil pH and increases nutrient availability.
- Annual overall nitrogen (N) supply from cover crops ranges from 20 to 200 kg of N per ha. While non-legumes provide 2,5 kg per ha per ton of fresh mass, legumes release around 4 kg of N. The longer the growth duration of legumes, the more nitrogen is fixed.



Prevention of nutrient losses

In warm soils in autumn, organic matter is rapidly mineralised, increasing water-soluble nitrogen (nitrate) levels. Without plant uptake (if the soil is left bare over winter), this nitrogen is lost through leaching, polluting groundwater and waterways. Timely sown cover crops, especially non-leguminous species, can retain most of the soluble nitrogen.



Build-up of soil fertility

- Soil organic matter increases water infiltration and improves the soil's capacity to store and continuously release nutrients and water, creating better growing conditions and reducing plant stress during drought periods.
- Mature cover crops (of more 'woody' consistency) can increase soil organic matter levels.



Reduction of erosion

- Cover crops ensure soil cover between main crops minimising the impact of rain and thus soil surface erosion.
- Furthermore, cover crops improve water infiltration through increased earthworm activity and better topsoil structure.



Suppression of weeds

- Fast-growing, dense cover crops (e. g. mustard or buckwheat) compete effectively with weeds for light, water and nutrients. They can prevent or reduce their development, spread and seeding.
- Annual or ideally perennial artificial meadows are needed to control root weeds such as couch grass or thistles.



Particularly fast-growing green manure species such as phacelia, alexandrine clover, vetches, oats and buckwheat are highly competitive against weeds.



Green manures promote biological activity in the soil and help to maintain its fertility.



Functional soil biodiversity

- Non-host cover crops contribute to the interruption of the life cycles of pests and diseases.
- Some cover crops (e.g. marigolds, bristle oats 'Pratex') can be used to control nematodes.
- Shallow incorporation of allelopathic species such as mustard, turnip rape, or oil radish can reduce soil-borne diseases. This practice is known as 'biofumigation'.



Possible forage utilisation

- Some cover crops can be fed to animals. Livestock-free farms may exchange the feed for manure for crop fertilisation.
- For high feed quality, the cover crops must be harvested at a stage that is suitable for forage use.

Potential challenges

Reduced water availability

If the cover crop draws heavily on the soil water reserves, water availability for the following main crop can be limited. Particularly in spring when water reserves may be low, water availability can become critical.

What to do:

- Select cover crops with minimal water requirements. Grow cover crops with higher water demand in wetter seasons only.
- Incorporate the cover crops early (4 to 6 weeks prior to planting of the following crop) and shallowly into the superficial soil layer (e.g. using shallow tillage) to ensure higher soil moisture levels.

Regrowth in cash crop

Some cover crop species can mature quickly and produce viable seeds. Germination of cover crop seeds in cash crops can become a major problem.

What to do:

- Choose cover crop species according to the available growth period.
- If necessary, advance the date of destruction of the cover crop just after flowering to prevent seed formation.
- If the cover crop has gone to seed, prepare the seedbed in spring twice within two weeks. First, to stimulate the seeds to germinate, and then again two weeks later, to destroy them, before sowing/planting the cash crop.

Pest and disease transmission

Cover crops may host pathogens that can affect the subsequent cash crops.

What to do:

- Select cover crop species from other botanical families than the cash crops (e. g. no sunflower before camomile, as both belong to the *Asteraceae* family).
- Use diverse cover crop mixtures.
- Rotate cover crop families in different seasons.

Production of toxic substances

Pyrrolizidine Alkaloids (PAs) are a major challenge in MAPs. They occur naturally in many plants and weeds, mainly as a mechanism to repel pests. They are highly toxic to humans, and have caused various cases of recalls of certain teas, culinary herb mixtures, etc.

What to do:

- In fields known to be infested, increase the density of the cover crop to smother any other plants. If toxic plants are found in the cover crop, bring forward its termination before viable seed is produced.



Green manures should be treated like primary crops. Good seeding and cultivation techniques are very important to ensure that they form dense and vigorous stands and realise their full potential.

Successful implementation of cover crops

Basic soil preparation

- Prepare the soil as soon as possible after harvesting the main crop to make the most of the growth period of the cover crop.
- Use a cultivator or a power take-off (PTO) driven machine for basic soil preparation. A chisel is suitable for light soils.
- Deeply loosen compacted soils in dry conditions, using a deep loosener or a low disturbance subsoiler followed by a deep-rooting cover crop mixture including, for example, oil radish.
- Where weed pressure is high, sow a dense, fast-growing mixture, such as buckwheat with millet and vetch. This will prevent the weeds from germinating and maturing as they will be finished off together with the cover crop. After termination of the cover crop, apply the 'false seedbed technique' preparing the seedbed 2 to 3 weeks before sowing and harrowing after 8 to 10 days to destroy germinated weed seeds.



Shallow but fine tillage is usually sufficient to establish cover crops. Reduced tillage conserves soil moisture and also saves time and operational costs when establishing the cover crop.



Applying animal manure, green waste compost and lime before sowing the cover crop increases nutrient availability for the cash crop by preventing potential nitrogen immobilisation in the soil.

Adequate fertilisation

- Apply manure, compost and/or lime before seedbed preparation if necessary.
- Apply liquid manures and liquid digestates only to fully established cover crops to prevent nitrogen losses.

Sowing

- Sow the cover crop soon after the main crop is harvested, especially when sowing frost-sensitive species.
- In case of late sowing in autumn, select hardy species that will ensure continuous growth and nutrient fixation until early spring.
- Elevated seeding rates result in denser stands and better suppression of weeds and volunteer plants.
- If available, use certified organic seeds. If not available, use untreated conventional seeds with the approval of your organic certification body.
- Use a cereal drill instead of a broadcasting seeder to ensure an even crop density and prompt germination.
- For summer seeding in dry soils, sow into deeper furrows of 3 to 5 cm depth.
- Rolling immediately after sowing ensures good seed contact with the soil and results in a higher seed germination rate.



Drill seeders with a small drilling width are particularly suitable for sowing green manures. In combination with a roller, they ensure an even emergence of the seed.



Terminating green manures at early flowering maximises the release of nutrients to the following crop and prevents seed formation.

Calculation of the seed rates in mixtures

1. Take the usual individual seed rates for pure stands of each species per hectare.
2. Take the proportions of the species in the mixture (e.g. 50 % summer vetch, 25 % oil radish, 25 % phacelia)
3. Multiply the seed rates by the proportions (e.g., summer vetch $0,50 \times 50 \text{ kg/ha} = 25 \text{ kg}$; oil radish $0,25 \times 20 \text{ kg/ha} = 5 \text{ kg}$; phacelia $0,25 \times 10 \text{ kg/ha} = 2,5 \text{ kg}$)

Important: If very dominant species are to be mixed with weaker species, the seed rates of the dominant species in the mixture should be reduced accordingly!

- Avoid cutting or mulching of cover crops during full flowering to protect flower-visiting insects. To minimise insect damage, cut the cover crops at night.
- High cutting of cover crops encourages vigorous regrowth.
- Driving on wet soil can destroy the benefits of cover crops.

Termination

- Mulching of young cover crops 3 to 4 weeks before their incorporation into the soil will increase nitrogen mineralisation, whereas the termination of older, woody stands may delay or reduce nitrogen availability.
- Cut or mulch grasses before panicle emergence.
- Ideally, dicotyledonous plants should be cut at the beginning of flowering.
- Ensure at least 3 weeks between termination of the cover crop and sowing of the following crop to enable decomposition of the plant biomass.



The superficial incorporation of the green manure into the soil accelerates its decomposition and minimises soil disturbance.

Suitable cover crop species for MAP in Kosovo

Table 1: Frost sensitive cover crop species for summer cultivation after cereals

Species	Latin name	Type/Family	Seeding density	Remarks
Summer vetch	<i>Vicia sativa</i>	Legume	50 to 65 kg/ha	Good drought tolerance and nitrogen fixation
Chickling peas	<i>Lathyrus sativa</i>	Legume	50 to 65 kg/ha	Good drought tolerance and nitrogen fixation
Egyptian clover	<i>Trifolium alexandrinum</i>	Legume	15 to 18 kg/ha	High forage quality, some species allow regrowth after a first cut
Bristle oat	<i>Avena strigoza</i>	Grass	35 to 50 kg/ha	Strong allelopathic effect on grass weeds, cheap seeds
Millet	<i>Panicum miliaceum</i>	Grass	25 to 35 kg/ha	Fast growing and soil covering, drought resistant, very frost sensitive
White mustard	<i>Sinapis alba</i>	Crucifera	5 to 7 kg/ha	Cheap seeds, very attractive for pollinators, suitable for biofumigation
Oil radish	<i>Raphanus sativus</i>	Crucifera	18 to 20 kg/ha	Enhance deep soil structure
Phacelia	<i>Phacelia tanacetifolia</i>	Hydrophyllaceae	10 to 12 kg/ha	Great nitrogen catcher, attract pollinators, topsoil structure enhancer
Buckwheat	<i>Fagopyrum esculentum</i>	Polygonaceae	35 to 45 kg/ha	Fast covering, soil phosphorus miner, risk of seed production
Nyger	<i>Guizotia abyssinica</i>	Asteraceae	8 to 10 kg/ha	Fast growing, strong nitrogen catcher, very frost-sensitive

Table 2: Over-wintering cover crop species for autumn sowing

Species	Latin name	Type/Family	Seeding density	Remarks
Hairy vetch	<i>Vicia villosa</i>	Legume	25 to 35 kg/ha	Very good soil cover, nitrogen fixation
Winter field bean	<i>Vicia faba</i>	Legume	120 to 180 kg/ha	Strong tap root (deep soil rooting), nitrogen fixation
Winter pea	<i>Pisum sativum</i>	Legume	100 to 130 kg/ha	Frost-resistant, easy to terminate in spring, good nitrogen fixation
Winter rye	<i>Secale cereale</i>	Grass	60 to 70 kg/ha	Good soil enhancer, difficult to terminate

Advantages of mixtures

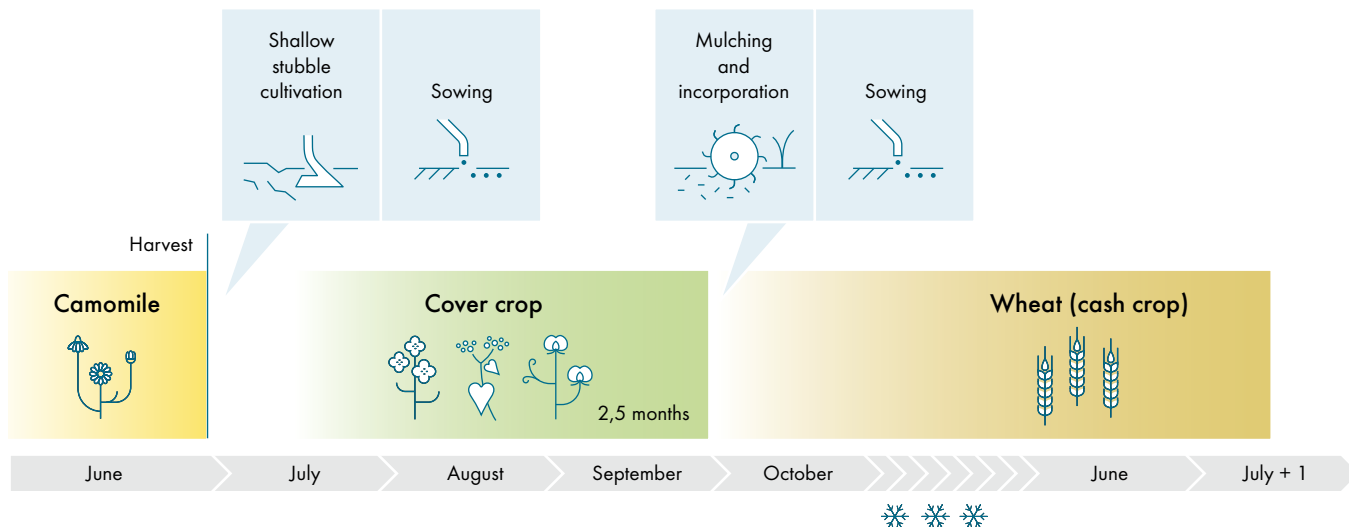
Mixtures of legumes and non-legumes have several advantages over pure seeds:

- They fix more nitrogen than pure stands of legumes.
- The non-legumes prevent nitrogen leaching more effectively than legumes.
- Mixtures make more efficient use of nutrients in the soil, partly because of the different rooting zones.

- The risk of pest and disease transmission is reduced.
- They adapt better to varying growing conditions, ensuring good biomass production.
- Calculate the seed rates based on the proportions of the species in the mixture. If a species is known to be very dominant, reduce the seed rate of the dominant species, and increase the rates of the weaker species.

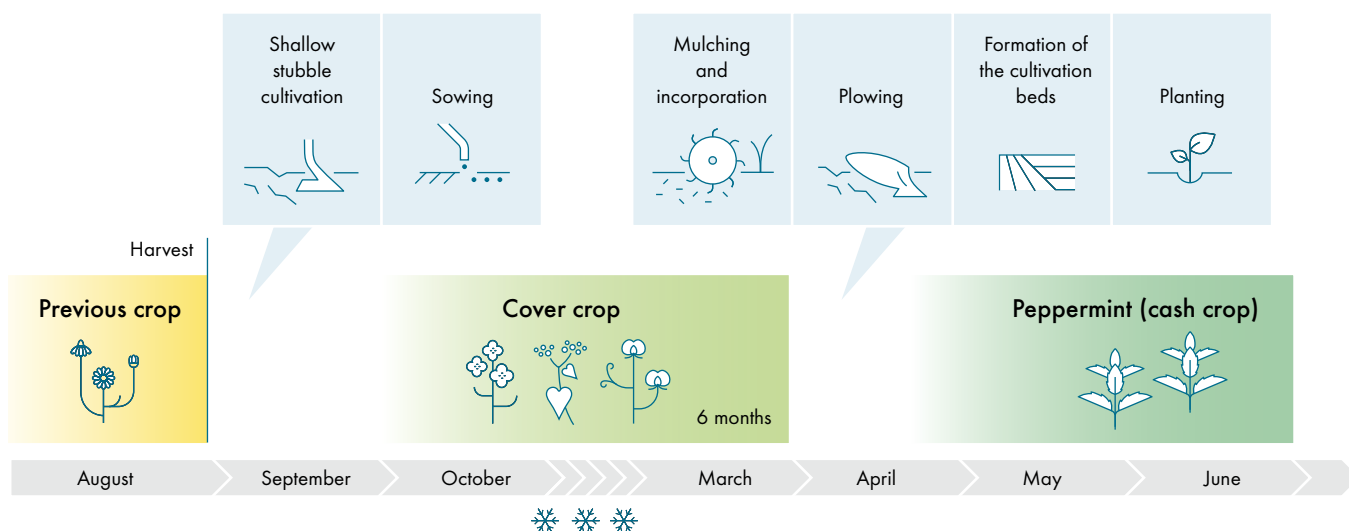
Examples of MAP crop rotations with cover crops

Example 1: A cover crop between camomile and wheat



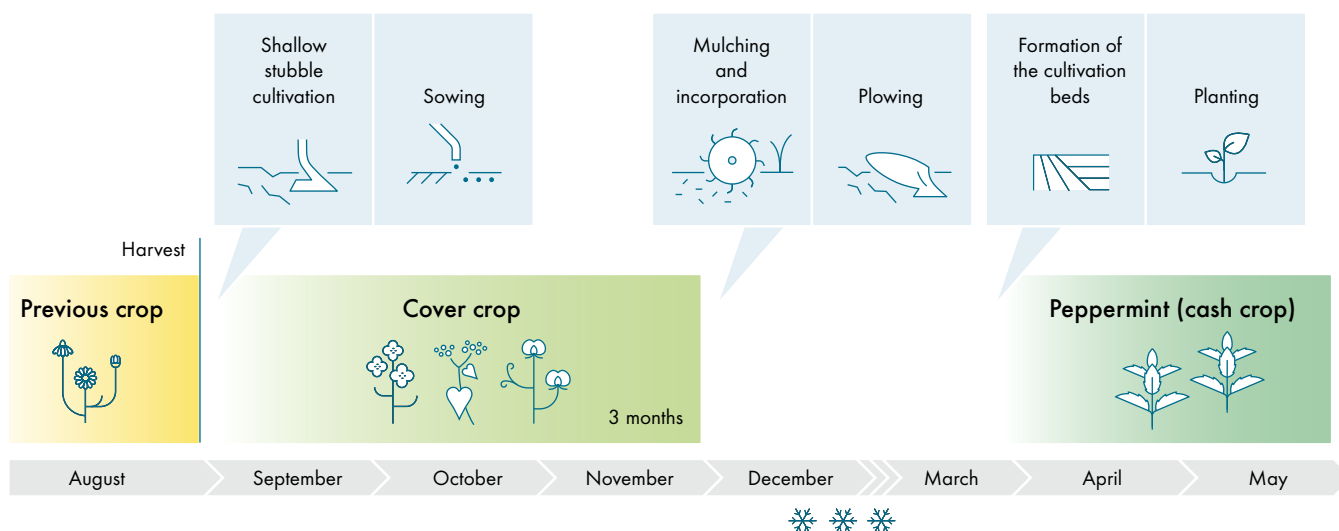
- Plant as early as possible after one shallow tillage operation to make the most of the limited time available for crop growth and nitrogen fixation.
- A mixture of three 'summer' legumes is suitable to rebuild fertility for the following cereal crop: chickling peas (25 kg) + summer vetch (25 kg) + Egyptian clover (5 kg).
- 3 to 5 kg of nyger can also be added, to efficiently capture the remaining nitrogen and quickly cover the soil.

Example 2: A cover crop between a summer harvest and a spring perennial plantation (e.g. peppermint) on lighter soils



- On lighter soils that allow ploughing in spring, a winter legume can fix considerable amounts of nitrogen, mainly in February and March. For good frost resistance, do not sow the legumes too early (ideal is early October).
- Winter peas (100 kg/ha) or winter vetch (35 kg/ha) are most suitable. Deeper stubble cultivation allows the legumes to perform fully during winter and early spring. Nitrogen fixation can reach 200 kg/ha.
- Additional 35 kg of winter rye will help structure the soil and trap leaching nitrogen.

Example 3: A cover crop between a summer harvest and a spring perennial plantation (e.g. Peppermint) on heavier soils



- On heavy clay soils, the aim is to produce as much biomass as possible between harvest and ploughing in late autumn.
- A mixture of chickling peas and vetch, with mustard, buckwheat, nyger and millet can develop fast in autumn.
- Shallow tillage is used to prepare a decent seedbed and conserve water for fast sowing after harvest.
- Mulching and ploughing of the cover crop in late November improves soil fertility and creates favourable conditions for soil cultivation in spring.

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