

Green manure management

Summary of the key points of Naturland Academy's Green Manure Management online seminar, 9th of November 2022. At the end of the recap, the Q&A section of the seminar and additional resources (i.e., links to the seminar recording [EN](#), [IT](#), [ES](#)) have been added.

Introduction to the Online Seminar & Naturland Academy by Thomas Holtz

Naturland actively participates in several European and international projects, giving us the opportunity to generate and collect a lot of knowledge on many different topics. Thus, Naturland decided to establish the Naturland Academy, a hub where collected knowledge is organized and shared. The goal is to provide our members, farmers, technicians, associates, and project partners with a portal where they can watch videos and read materials on organic agriculture. Soon the portal will be ready and shared with all our members.

Green manure management is particularly important for all our members worldwide. Soil fertility is the basis for organic agriculture, and all the practices that aim to increase it should be studied and correctly applied. In the following pages we provide you with information on green manure management.

Green Manure Management by Alessio Capezzuoli

Alessio Capezzuoli works as a technician for many Italian farmers since many years. He studied agriculture at the university of Firenze, and after a few experiences in Spain and in the United States, he decided to specialize in organic agriculture. During those years, he worked on soil fertility using green manure.

Green manure is an ancient agronomic practice of sowing an herbaceous crop composed of pure or consociated essences intended to be mowed and buried. This practice **brings advantages to the following crop and generally increases the soil fertility when well-structured and managed.**

The sowed species are usually fodder crops and are generally mowed near flowering time. The chopped plants can be immediately buried if you are looking for rapid degradation or can be left to dehydrate for a few days and then incorporated into the top 25 cm of soil. The buried mass is immediately attacked by macros and microorganisms that transform the chopped plants partly into humus and partly into readily usable nutrients (especially nitrogen). These nutrients are then used by the following crop. The more fiber it contains, the greater the humus yields.

It must be clear that green manure is not a universal solution that is applicable in the same way on every farm. It is fundamental to understand that green manure can have different purposes! It can highly improve the organic nitrogen content of the soil or be used to increase the stable fraction of humus, thus increasing the long-term soil fertility. Green manure can also be used to decrease pathogenic nematodes, it also reduces soil erosion and improves the water and nutrient retention of the soil! Below, a brief explanation of **the main practices that can be used on an organic farm.**



Picture: 1 Red Clover, *Trifolium pratense* (Source: Pixabay.com)

Nitrogen increment and short term-fertility

Legumes are well known for their ability to provide organic nitrogen to the soil where they grow. To understand how legumes function, it is important to keep in mind that the nitrogen is located in the nodules of the roots until the fruits or seeds start to grow. To increase the nitrogen content in the first 20 – 30 cm of the soil, the plants should be mowed and incorporated during blooming.

In regions with cold and rainy winters, it is possible to use cover crops to reduce nitrogen leaching and soil erosion. During spring, the plants will be mowed, and the nutrients will become available to the next crop. For this purpose, rye, ryegrass, and mustard are very effective.

These two practices provide organic matter and increase soils' organic nitrogen pool, consequently increasing the amount of mineral nitrogen available for the following crops.

Green manure composed of legumes, when correctly managed, can provide dozens if not hundreds of kilograms of organic nitrogen per hectare. This **reduces the need for external fertilizer inputs and, consequently, the economic expenses.**

Table 1 has a list of different leguminous species. When using certain legumes, it is important to introduce microbial inoculum (i.e., soybeans, Sulla, etc.) to take advantages of nitrogen fixation.

Name	Advantages	Comments
Egyptian clover (<i>Trifolium alexandrinum</i>)	Rapid development, resistant to salinity and alkaline soil, tolerates clay soils	
Squarrose clover (<i>Trifolium squarrosum</i>)	Resistant to cold, adaptable to clay and calcareous soils.	
Italian clover (<i>Trifolium incarnatum</i>)	resistant to cold, adaptable to clay soils (not excessively alkaline)	
Persian clover (<i>Trifolium resupinatum</i>)	resistance to salinity, high pollen production (bees).	
Common vetch (<i>Vicia sativa</i>)	Adaptable to many soils	Fears the winter cold and stagnation of humidity

Table 1: Common leguminous species used as green manure.

Nitrogen increment and long term-fertility

Using the same procedure as described above, with the difference that the plants can be mowed when the pods are formed. The C/N ratio will be higher, and the organic matter introduced into the soil will be steadier than in the above procedure. Biodegradation is directly related to the cut dimension: the larger the pieces, the slower the reaction. High levels of organic matter increase soil fertility (as organic matter is rich in nutrients) and provides structure to the soil, improving water drainage on heavy soils and retention on light soils. It also sustains a stable and resilient microbial community.

Organic matter and long term-fertility

Gramineae species (grasses), see Table 2, are rich in fiber and can be exploited to recover deep-buried nutrients in the soil. The deep root system of herbaceous species can reach immobilized or "lost" nutrients and transfer them to the upper part of the plant. After mowing and incorporation, the nutrients are transferred to the first 20 cm of soil and are bound to organic molecules available for future crops. A good level of organic matter in the soil is also essential to avoid and reduce possible micro-nutrient deficiencies. Gramineaceous species should be mowed before or during the

flowering time to avoid an excessive C/N ratio and, consequently, mineral nitrogen availability reduction. The same phenomena occurs if the graminaceous are sowed as single family and not in a mixture with legumes and Brassicaceae, this phenomenon is known as “nitrogen hunger” effect.

Name	Advantages	Comments
Barley (<i>Hordeum vulgare</i>)	Very adaptable, premature, resistant to drought and salinity	Beware of Nitrogen hunger effect
Triticale (<i>Triticum aestivum L.</i>)	Very adaptable (to terrains and weather)	
Rye (<i>Secale cereale</i>)	premature, easy to grow, excellent resistance to cold	Beware of Nitrogen hunger effect
Oats (<i>Avena sativa</i>)	Rapid covering, adaptable to all terrains	
Ryegrass (<i>Lolium multiflorum</i>)	Rapid growth	

Table 2: List of grasses species used as green manure.

Soil fertility and structure improvers

Some **Brassicaceae** or **Cruciferae** species (Table 3) can reach deep into the soil, providing oxygen to deep layers, loosening compacted soils, and draining excesses of water. These crops grow rapidly and have a C/N ratio between grasses and legumes species, allowing plants to release nutrients in shallower soil layers and rapidly increase the soil's organic biomass. It's the ideal choice to improve the characteristics of thin sandy soils or make light and ventilate clay soils.



Picture: 2 Rapeseed, *Brassica napus* (Source: Pixabay.com)

For example, the **Radish Tillage** is characterized by a large taproot that penetrates the soil up to 50 – 60 cm deep and creates a series of wide, closely spaced holes that are ideal for drainage and structuring of soils, even with heavy soil. Tillage Radish naturally disintegrates through winter frost, leaving its taproots completely deactivated and soft in the soil. After that it is possible to perform a light harrowing or direct seedling.

Name	Advantages	Comments
Mustard (<i>Nigra, Alba, Juncea</i>)	Biofumigant action, high pollen production, assimilate and mobilize P and K (<i>Juncea</i>), high organic matter production	Do not tolerate cold
Horseradish (<i>Armoracia rusticana</i>)	Short cycle, very competitive with weeds	Needs to be shredded no later than complete flowering
Fodder rapeseed (<i>Brassica napus subsp. napus</i>)	Organic matter of excellent quality	
Rocket (<i>Eruca vesicaria</i>)	Fumigant action against Nematodes (contains glucoerucin) and pathogen fungi, short cycle	Ventilate greenhouses before entering
Radish Tillage (<i>Raphanus sativus</i>)	Excellent drainage, Frost-tender plants	

Table 3: Some Brassicaceae species used as green manure.

Biocide effects during rotting

Some species of the Brassicaceae family showed biocide properties and can be used to reduce the Nematodes population. For example, *Eruca Sativa* is one particular rocket that grows up to 60 – 80 cm tall, and when mowed immediately releases some organic molecules that act as biocide against soil Nematodes. When this rocket is used in greenhouses, it is possible to close the glasses/plastic foil and wait one week to increase the biocide effect. After that, the organic matter should be incorporated into the soil. Before accessing the greenhouse, it is fundamental to ventilate the area to ensure workers' safety.

Spontaneous weeds control

Fresh, bare soil is the perfect place to be colonized by spontaneous weeds. Furthermore, the organic matter contained in the soil is exposed to oxygen and degraded. The perfect solution to protect and prepare the soil for the next crop is not fallow but green manure. Green manure, when well-managed, suppresses the germination of spontaneous weed because of shading and allelopathy, decreasing slowly the seed's pool naturally contained into the soil. This practice allows to reduce tillage frequency, and consequently the petrol consumption. The ideal species to control summer weeds are fast-growing competitive species, better if drought resistant.

What do we ask from green manure?

Among the most desired features we should absolutely mention:

- **Rapid growth:** Optimizes the timing and reduces weed competition
- **Competition against spontaneous weeds:** Necessary to make the most of our green manure
- **High biomass production:** To increase the organic matter of the soil
- **Producing huge quantities of nitrogen:** At a low cost compared to the equivalent purchased at the market
- **Roughness:** It should survive without any other input or effort from farmer side
- **Drought resistance:** Necessary for green manure in summer

How to choose the mixture

Using a mixture of plants instead of just one species brings the best results. The plants are selected in function of the soil, season, water availability, crop-duration, the purpose of the green manure, and the agricultural machinery present on the farm. It is fundamental to observe the spontaneous weeds that already grow in the field as this can be used as an environmental bioindicator (wet soil, shallow roots system, nitrophile species, etc.) and help with the selection. It is possible to find some databases on green manure plants online. See below for additional resources.

Some green manure plants produce a lot of nectar and pollen that bees can use to produce honey. In Italy, some farmers have already collaborated with beekeepers or started their own honey production in combination with the green manure practice. This synergy reduces costs and improves the ecosystem services.

How to prepare the soil

Soil preparation is fundamental to obtain an optimal seeds germination and development. There are multiple practices: from the no-tillage to double tillage, all aimed at safeguarding the fertility levels while containing costs. In case of high weed pressure, false sowing reduces competition and favors green manure growth. A ripper and a tiller are often the most used choices. The depth of sowing differs for every species and must be observed. Finally, if the soil is tilled, after seeding (mechanical or manual) it is important to lightly compact the soil with a roller.

Green manure mowing and incorporation

The optimal mowing and incorporation time to take advantage of the most rapid release of nutrients is before the blooming stage. At this stage of the growing cycle, the plant has reached its maximum development, and from that moment, it begins to increase the percentage of fiber in the tissues. It means that the C/N ratio rises and, with it, the biodegradation time. A "mature" green manure becomes very significant for the humic balance. It is possible to estimate about two kilograms of stable humus produced per quintal of green mass buried as long as the biomass is homogeneously distributed, properly shredded, and well buried. This procedure doesn't increase the immediate nutrient availability but gradually increases the useful reserve that slowly mineralizes.

If the C/N ratio is too high, the mineral nitrogen naturally available in the soil will initially decrease, as the microbic population will use it to grow to start microbiological degradation. For this reason, it is essential to balance the percentage of legumes, grasses and brassicas.

Roller crimper

It is possible to use a roller-crimper on loose and fresh soils. This system allows bending and laying the plant stems on the ground, keeping them alive for several weeks. The plants act like natural mulching and protect the soil from wind and water erosion. Once weeds naturally dried, it is possible to perform sod seeding; the new plants will germinate and will take advantage of the natural mulch left on the ground.

Keep in mind

The compatibility of the green manure (cover crops) with the rotation of the main crops must be checked, it's possible to do it using for example best4soil database. Without a proper plan, there is the risk of increasing Nematodes and pathogens into the soil.

Naturland Standards and legumes

Naturland Standards states that at least 20% of the cropping area of arable crops must be cultivated with leguminous plants as a fundamental measure to increase soil fertility. For permanent crops and plantations, undergrowth is mandatory. No area shall be entirely free of vegetation or other plant coverage throughout the entire year. Exceptions are made to allow green manure sowing. See [Naturland Standard on Production](#) for details.

Questions from the audience

1. Can biodynamic preparations stimulate soil microorganisms and the biological balance of the soil?

In the Naturland standards, we do not request any biodynamic preparations. Some farmers recognize and use biodynamic preparations, but this question is outside our competence area. Please contact some biodynamic farmers.

2. Does Naturland allow the use of humic acid?

Naturland allows humic acid as fertilizers and bio-stimulants if registered for organic agriculture and originated from permitted raw material (see link – [Naturland Standards](#)).

3. How to plant and manage green manure trees in thick mature cacao plantations?

Cacao plantations are often thick and shaded and only a small fraction of the light reaches the ground. It's important to till the soil, especially if it is particularly compacted. After preparing the soil, it is necessary to sow plants that are naturally adapted to shaded environments. Irrigating the sowed soil might be necessary, stimulating germination and roots development. For more information refer to item IX Permanent Tropical plantation (including 3.5 Crop-specific provisions for cocoa) in the [Naturland Standards on Production](#) and to [Cocoa Cultivation Guidelines](#).

4. How to manage green manure in Arid/ Tropical Areas?

In general, when it comes to arid/ tropical areas, the process is quite similar. It is fundamental (in every region!) to use native/already cultivated species to avoid the introduction of alien species. Native plants are naturally adapted to the local climate, and thus advantaged. Before ordering any seed, look at your soil. Which plants are naturally growing?

When it comes to arid regions, it can be more challenging to practice green manure. It depends on the season and water availability. If there is water or the possibility of irrigating, it's feasible; if the water is scarce, you need to find drought-resistant species.

In tropic regions, it is necessary to carry out the sowing before the start of the rainy season. If the seeds are not well germinated and anchored to the soil, they will be washed away from the rainwater. If combined with the roller crimper, it is possible to obtain a good mulch that will protect the soil from water erosion.

5. What is your opinion on Crotalaria Juncea?

This plant only recently appeared in Italy, and it's also used in greenhouses. Crotalaria Juncea is a legume, but the observed nitrogen input, compared to other species, is lower. It is though interesting for the bio-fumigation effects that showed, particularly effective against nematodes.

6. What is the relation between the lunar phases and the ideal sowing time?

The lunar phases are important, and Alessio suggests sowing during a waning moon. The moon is important, but it is much more important to ensure germination and plant development before heavy rain.

7. Which species would be the most resistant to drought in heavy soils? For south-eastern Spain?

This question requires some studies and background information, and we cannot give you a full answer without having more information (see Alessio contacts).

Additional material and resources

Green Manure Online Seminar Resources:

English

- [Video EN: Green manure in horticulture – Recording Nurland Online Seminar](#)

Italiano

- [Video IT: Gestione del sovescio – Registrazione Nurland Seminario online](#)

Español

- [Video ES: Abonos verdes en la horticultura – Grabación Nurland Seminario online](#)

Additional Resources

- Orticultura Bio, <https://www.orticolturabio.it/> Alessio Capezzuoli webpage in Italian
- [Nurland Standard on Production](#)
- [Video of “Crop Rotation Best Practices” and access to factsheet](#); Best4Soils (in multiple languages)
- [Video “Green Manures and Cover Crops, practical information”](#) ;Best4Soils (in multiple languages)