

CULTURAL MANAGEMENT OF GREEN MANURE CROPS FOR THE SUGAR BEET CYST NEMATODE MANAGEMENT

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What is a green manure crop? A green manure crop is a crop whose main purpose is to benefit the soil or other crops in one or more ways, but is not to be harvested for feed or sale. They may hold the top soil in place during a heavy rain, their residue helps to improve the soil's physical structure, or they disturb weed or pest cycles to help cut pesticide costs the following season.

GREEN MANURE CROP MANAGEMENT STRATEGIES

To effectively reduce nematode populations, green manure crops require at least eight weeks growth. Green manure crops can be planted either in early spring or late summer. Often, the green manure crop can be conveniently planted after the grain harvest. Green manure crops should be managed as carefully as main crops to obtain maximum benefits. The following factors should be considered in managing green manure crops.

1. Cultivar Selection
2. Planting Date
3. Field Preparation
4. Planting
5. Fertilization
6. Irrigation
7. Weed control
8. Incorporation
9. Economics

Cultivar selection

The choice of an appropriate cultivar will depend on the primary reasons for including the green manure crop in the rotation, adaptability of the cultivar to the local climatic conditions, and types of crops grown in the rotation. One of the main reasons to grow white mustard or oilseed radish is to suppress nematodes, weeds and diseases. The best choice in most situations will be a cultivar that grows well in the particular region. However, there is good information on using oilseed radish or white mustard to suppress sugarbeet cyst nematodes. The nematode suppression results from the green manure crop's ability to "fool" the nematodes into hatching when a good host plant is not present.

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European scientists developed a green manure cropping system based upon development of sugarbeet cyst nematode-resistant varieties of oil radish and white mustard that produce this hatching factor. These special varieties produce enough hatching factors during a 8-10 week growth period to initiate hatching of the cyst nematode eggs. The newly hatched worms quickly invade the roots, but in these specially developed varieties the nematodes do not develop into egg-laying females, and reproduction does not occur. Few viable eggs remain in the soil to infect the next crop of sugarbeets. Studies at the Parma Research and Extension Center indicate that certain cultivars provide better suppression of cyst nematodes than do other cultivars.

Planting Date

A major concern in growing radish and mustard green manure crops is the relatively long growth period required to produce an acceptable amount of plant biomass. To achieve the best results, green manure crops should be planted as early as possible either in spring (first two weeks of March) or late summer (last week of July to third week of August). It takes 8 to 10 weeks of at least 60°F soil temperature to get satisfactory plant growth and cyst nematode suppression. Frost is also a concern because it will kill the plants if the temperature drops below 25°F for mustards, or 22°F for oil radishes. Early plantings generally produce more plant biomass, provided frost damage is avoided. Planting dates in other regions should be adjusted according to local soil and air temperature conditions, and danger of a killing frost.

Field preparation

Because early planting is critical for the effectiveness of green manure crops, it is important to quickly incorporate previous crop residues and perform tillage operations to loosen the soil. To obtain best results if the green manure green manure crop follows a cereal crop, the field should be prepared by removing the straw by baling, burning residue, or chopping as short as possible and incorporating into the soil immediately after harvest. Loosen soil deep enough to allow dense root penetration and optimum aeration for hatching of cyst nematode eggs. These tillage operations can also be used to incorporate fertilizer. If time permits, irrigate to germinate volunteer cereal and weed seeds. Finally, prepare a good, firm seedbed to encourage rapid germination and establishment of the green manure crop.

Planting

Planting can be accomplished with a grain drill, or the seed can be mixed with fertilizer and applied with a fan spreader truck. A light harrowing would be necessary to cover the seed after spreading. Seeds should be covered to a depth of ½ to ¾ inches. A seeding rate of 25 lbs per acre is recommended to insure a dense stand that will reduce weed competition. A dense stand is also required to stimulate adequate hatching of cyst nematode eggs.

Fertilization

Approximately 50 lbs N per acre is required to establish a good crop of radish or mustard. An additional 15 lbs N per acre should be applied for each ton of straw incorporated

following a cereal crop to aid decomposition (up to 50 lbs N/acre). The nitrogen added to the green manure crop should be taken into account when determining nutrient requirements for the following crop.

Irrigation

Adequate soil moisture and aeration are important for both seed germination and nematode egg hatching. Following a cereal crop, the soil is usually very dry and irrigation is required immediately after the green manure crop is planted. Under gravity irrigation systems, furrows should be put into the field shortly after planting. For sprinkler irrigation systems, water can be applied immediately after planting to promote rapid germination. After the plants emerge, a minimum of three irrigations are necessary to provide adequate plant growth and to stimulate nematode egg hatching.

Weed control

Weeds act as alternate hosts for numerous diseases and nematodes, and thereby reduce the effectiveness of green manure crops. Weeds also provide competition and reduce growth of the green manure crop. Weed control in green manure crops can be accomplished with several integrated management practices. Pre-irrigation will help germinate volunteer grains and broadleaf weeds so that they can be controlled by tillage before planting. Establishment of a dense stand of radish or mustard will also reduce weed populations. There are several herbicides registered for broadleaf and grassy weed control in radish and mustard crops. However, plant back restrictions and carryover effects on the following crop should be carefully considered before application of any herbicide to a green manure crop. Registered herbicides for preplant or pre-emergence control of broadleaf weeds include Dacthal, Roundup, and Treflan. Poast is registered for post emergence control of grasses. Consult the label for specific use rates and restrictions.

Incorporation

The effect of timing and method of incorporation of green manure residues on pest suppression is well understood. Current incorporation recommendations are mainly based on cultural factors. In most situations it is advisable to incorporate the radish or mustard residues while the tissue is green and before seed formation. This will help prevent problems with volunteers in subsequent crops. In regions where cole crop seed is produced, the prevention of seed formation is essential, and may be required by local regulations. The residues should be chopped as finely as possible to facilitate incorporation and breakdown in the soil. After chopping, the residues should be incorporated by disking or plowing. In regions where soil erosion is a concern, the residues may be left on the soil surface during vulnerable periods.

Economics

Growers who plant green manure crops in Idaho report total variable costs of \$45 to 90 per acre for establishment of the crop. Seed costs usually make up the largest portion of the total cost of establishing the crop. Under the standard rotation, Temik would be required for control of sugarbeet cyst nematodes. Under the green manure system, Temik

would not be required, but in addition to seed, there are additional expenses for tillage, fertilizer, irrigation and Poast (for control of volunteer grain in the green manure crop). The additional expenses incurred in producing these green manure crops should be weighed against the benefits of reduced pesticide use and improved crop yield and quality. However, it should be pointed out that many of these benefits are difficult to measure, and are very dependent on the management systems.

FITTING GREEN MANURE CROPS INTO YOUR CROP ROTATION SCHEME

Deciding when to plant a green manure crop depends on the rotation program and on the availability of irrigation water. Late summer-planted oil radish can be followed by beets the next spring, but an additional season with a non-host rotation crop such as winter wheat, onion, potato, corn, or beans will provide a higher level of nematode control, and the potential for a better crop of sugar beets the following year will be increased.

To most effectively reduce sugar beet cyst nematodes, green manure crops require 8 to 10 weeks of growth with soil temperatures above 60° F. This long growing period may be difficult to achieve when frost is expected. Oil radish tolerates frost as low as 22° F, while mustard cannot withstand frosts below 25° F. However, such concerns may be alleviated for late summer-planted green manure crops as faster growing varieties become available.

BENEFITS OF GREEN MANURE CROP

Specific green manure crops can effectively manage sugar beet cyst nematode (SBCN). Special varieties of SBCN-resistant oilseed radish (*Raphanus sativus* ssp. *oleifera*) and white mustard (*Sinapis alba*) have been developed for enhanced SBCN management. When these green manure crops are grown in nematode-infested soil, chemical root exudates trigger hatching of nematode eggs but the larvae that emerge are unable to develop into reproductive females. Nematode population densities (cyst) then decline, and conditions are again more favorable for sugar beet production. In several field experiments conducted in Parma, Idaho, use of green manure crops consistently reduced population densities of SBCN by six- to eight-fold. Average SBCN population reductions of 84% to 92% were obtained. Field validation trials conducted in northwestern Wyoming showed similar results. Sugar beet cyst nematode population reductions of 19 to 69% were reported in commercial fields when oil radish 'Adagio' was used. Green manure crops are presently used on about 110,000 hectares (250,000 acres) in Germany. Green manure crops of oilseed radish and white mustard provide several benefits to sugar beet crop production system as follows.

Cut the fertilizer bill

A well-established green manure crop often can reduce fertilizer N needed to grow sugar beet. How much N the green manure crop provides, and how fast the N becomes available for subsequent cash crops, will depend on the species of green manure crop and on its growth stage when killed. It also depends on the amount of N already available in the soil.

Reduce soil erosion

Simply holding the soil in place is the most obvious way that green manure crops reduce erosion. But green manure crops also reduce the explosive impact of raindrops, which is a notable benefit when heavy rains fall on sloping soils that have poor infiltration. By enriching the soil with organic matter, green manure crops improve infiltration, so that more water goes into the soil instead of running off the surface.

Cut fuel and irrigation costs

The dollars-and-cents value of this benefit will vary among farms and years. But the ability of green manure crops to break up plowpans and to improve soil physical properties (such as tilth and water-holding capacity) can mean big savings at the gas pump and irrigation well.

Cut herbicide costs

Many green manure crops can shade and smother weeds, or outcompete them for soil moisture and nutrients at various times of the year. Some cover-crop residues contain compounds known as allelochemicals, which suppress the growth of other plants. The best way to take advantage of allelopathy is to mow or spray the cover and manage it as a mulch, instead of incorporating it.

Reduce insect problems

Green manure crops can play a key role in the insect control program, mainly as a way to attract beneficial insects that prey on pests. Flowering buckwheat attracts hoverfly, for example, whose larvae attack aphids. By choosing green manure crops that attract beneficial insects, it is possible to avoid species that also attract pests. Mowing reduces the ability of green manure crops to support many beneficial insects.

Reduce soilborne diseases and nematodes

Green manure crops in rotation can greatly influence soilborne diseases, although the effect varies depending on the cultivar of green manure crop. When alfalfa is incorporated into the soil, it may greatly reduce the fungus *Sclerotium rolfsii*. Green manure cropping also can suppress plant-parasitic nematodes in a number of ways. Sometimes the covers simply act as "non-hosts," preventing nematodes from reproducing or their roots give off compounds that stimulate activity of nematodes, which then die in the absence of a suitable host. Finally, the roots and foliage of some green manure crops may produce compounds that are deadly to nematodes. Advantage of this benefit requires to know what nematode species exist in the field.

Minimize groundwater pollution

Green manure crops are great "sinks" for taking up and storing residual (leftover) N from manure and fertilizer applied to previous cash crops. Cool-season grasses with a deep, dense root system (such as annual ryegrass) or that produce lots of above-ground biomass (such as grain rye) are very good for recovering residual N. Overall, non-legumes are about three times more efficient than legumes at reducing N leaching.

WHAT TO AVOID IN MANAGING GREEN MANURE CROPS

To achieve the best nematode control with green manure crops, the following factors should be avoided:

- Planting late
- Poor seedbed preparation (e.g. leaving straw or stubble on the soil surface)
- Over-watering and under-fertilizing
- Weeds and volunteer grain
- Inadequate seeding rate

CONCLUSIONS

Green manure crops of oilseed radish and white mustard provide several benefits to sugar beet crop production system. One of the main reported benefits of these green manure crops is to reduce populations of nematode, weed and disease pests. Pesticide inputs to sugarbeet crops can often be reduced because of the lower pest pressure when these crops follow oilseed radish or white mustard. Compared to standard rotations, higher quality sugarbeet crops are generally grown on soils where oilseed radish or white mustard residues have been incorporated. The residues from these green manure crops add humus that improves soil tilth, water holding capacity, and nutrient availability. Fall-planted green manure crops can reduce soil erosion and tie up residual nitrogen from the previous crop that might otherwise be leached below the root zone during the winter. Nutrients taken up by the green manure crop are released into the soil after incorporation of the residue, where they become available for uptake by the following crop.