

COVER CROPS

for Vegetable Production in the Northeast

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Introduction

Cover crops are close-growing crops that are grown primarily to protect and improve the soil. Integrating cover crops into vegetable production systems offers many benefits but also presents some challenges. For cover cropping to be successful, the grower should know the intended purpose(s), consider important management factors, and understand the characteristics of different cover crop species.

Benefits of cover crops include addition of organic matter to soils; improvement of soil tilth and remediation of compaction; protection of soil from wind and water erosion; addition or recycling of plant nutrients; increase in biological activity of soil; retention of soil moisture; and in some cases suppression of weeds, insects, pathogens, and nematodes. Because no single cover crop can provide all of these benefits, matching the need and the opportunity with the right cover crop requires information and planning.

Cover crops perform best under good growing conditions such as optimal temperatures, sufficient soil moisture, and adequate soil fertility. Such practices as preparing an adequate seedbed; drilling seed or broadcasting and cultipacking; inoculating seed with the proper *Rhizobium* inoculant if using a legume; planting into sufficient soil moisture; correcting pH or soil fertility problems; and, in some cases, controlling weeds with herbicides or mowing the cover crop in midseason, often further enhance cover crop performance. In addition, it is critical to have access to appropriate equipment for incorporating the cover crop.

Despite the relatively short growing season in the Northeast, there are many ways to integrate cover crops into vegetable rotations. This can be done, for example, by planting grain rye or wheat after vegetable crop harvest; interseeding ryegrass or clover into a standing vegetable crop; no-till planting pumpkins into an herbicide-killed rye mulch; planting barley windbreaks in muck-grown onions; or taking land out of production for a season of cover cropping.

The costs associated with cover cropping include seeds, time, labor, and equipment use. Growers should consider these costs when deciding which cover crops to plant. "Opportunity costs" (the cost of the lost opportunity of growing a cash crop) should also be considered.

Some cover crops pose specific management challenges, and others can have detrimental effects. For example, grain rye left to grow into late spring or sudangrass that is left unmowed in the summer can grow so vigorously that they are difficult to incorporate into the soil and can cause nitrogen immobilization. Direct seeding large-seeded vegetable crops into soil with fresh organic residues invites seed maggot damage. Some cover crops, such as hairy vetch, are hosts for common nematodes or soil-borne diseases such as white mold.



Cool-season brassicas grow rapidly during the fall following early-harvested vegetables. Brassicas are excellent nitrogen scavengers and may be used to suppress weeds and soil-borne pathogens.

Before growing any new cover crop, try it first in small test strips. In addition, consult your local extension educator for more information on specific cover crops.

The commonly grown and most promising new cover crops are described in the following sections. A range of seeding rates is given for most cover crops. In general, lower rates are used when drilling seed; higher rates are used when broadcasting and rolling or cultipacking. Most cover crops, except where indicated, will become better established when seeds are drilled.

Nonlegumes

Oats

Seeding rate: 80–120 lb./acre

Timing: August–early September

Description: Non-winter-hardy small grain

Comments: Oats may be used as a cover crop in fall or spring. If left untilled, a fall oat cover crop will leave a dead mulch residue in spring that suppresses weeds. Oats are easier to incorporate in spring than rye, and they work well if grown in a mixture with hairy vetch. Like all small grains, oats are not a host of most plant pathogens of vegetables and thus make an excellent rotation crop. Major benefits include weed control, erosion control, and additions of organic matter. Oats are not particularly effective at producing deep roots capable of breaking up compacted soil layers.

Wheat

Seeding rate: 80–110 lb./acre

Timing: Mid-September–early October

Description: Winter-hardy small grain

Comments: Wheat is an excellent rotation crop for breaking many vegetable disease cycles and is frequently used as a cover crop in New York. Spring regrowth is not as vigorous as rye. Wheat may cause nitrogen immobilization and encourage seed maggots if a vegetable crop is planted too soon after incorporation.

Rye

Seeding rate: 100–140 lb./acre (2 bu/acre)

Timing: Late August–early October

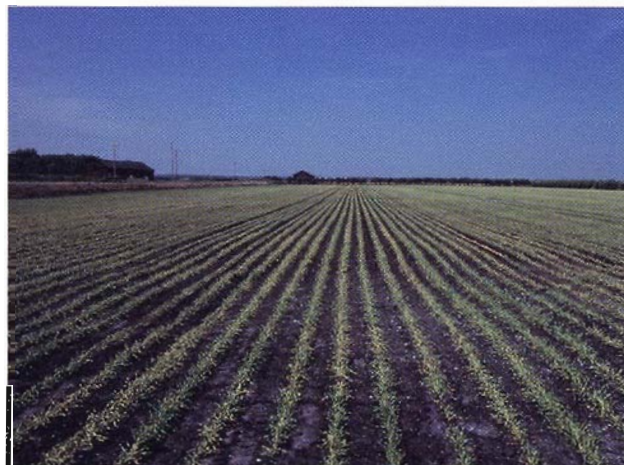
Description: Winter-hardy small grain

Comments: Rye is used extensively in the Northeast in part because it can be planted later than any other cover crop. Planting too early (before mid-August) can cause seed-heads to form before winter in mild years. Rye tolerates a

wide range of growing conditions and is somewhat tolerant of atrazine so it can follow a corn crop. Primary benefits of grain rye are winter erosion control, uptake of leachable nitrogen, weed and disease suppression, and additions of organic matter. Compared to sudangrass and perennial ryegrass, it does not have a particularly deep or abundant root system for remediating compacted soils, but it is a very hardy crop that may be able to grow on compacted, poor-quality soils better than many other cover crops.

Spring regrowth can be vigorous, making incorporation difficult. Rye can be mowed in the spring before it heads or exceeds 18 inches in height to kill the crop mechanically. Vegetable crops planted too soon following incorporation of a rye cover crop may suffer from seed maggot damage, nitrogen immobilization, seed or seedling decay, or allelopathic effects of the decomposing rye. For these reasons, it is best to delay planting at least two weeks following incorporation. Rye has been shown to delay growth in snap beans when soils are wet during and after incorporation.

A mixture of rye and hairy vetch has proven successful in many trials, and it will produce considerable biomass if left to grow into May. Typical seeding rates are 50 to 60 pounds per acre of rye and 30 pounds per acre of vetch, with an ideal planting date between August 15 and September 1 in the Northeast. The advantages of the mixture include quicker establishment and better winter survival of the vetch than when grown as a monocrop, potential for greater overall biomass than either crop grown alone, easier mowing in spring, and reduced risk of nitrogen immobilization in the spring. The nitrogen contribution from such a mixture, however, may not be as great as if vetch were grown alone.



Spring barley is used extensively in onion production areas in New York specifically to minimize spring wind erosion on muck soils. The barley emerges before the onion plants (left), forming windbreaks for the emerging onion seedlings. Later, when the onion seedlings are bigger (right), the barley is killed by a slow-acting selective herbicide.

Barley

Seeding rate: 90–120 lb./acre

Timing: Early spring or early fall

Description: Non-winter-hardy small grain

Comments: Barley does not tolerate wet soil, low pH, or low fertility. It is used extensively on muck soils as a windbreak for onion plantings. Once onions become established, barley can be killed with a selective grass herbicide.

Ryegrass

Seeding rate: 18–20 lb./acre

Timing: August–early September

Description: Cool-season, low-growing grass

Comments: Both perennial and annual types are used as grass cover crops. Each is quick growing, but perennial types have a more extensive root system that can grow fairly well in compacted soils. Annual ryegrass will not survive most Northeast winters; perennial ryegrass survives more frequently but will not live through every winter. When ryegrass does not winter-kill, it can regrow abundantly the following spring. Ryegrass provides excellent erosion control and tolerates shade, so it is useful for overseeding into standing crops.

Brassicas

Seeding rate: 10–12 lb./acre

Timing: Late August–early September

Description: Broadleaf annuals and biennials

Comments: Brassica cover crops are closely related to cabbage and grow rapidly in cool weather. Annuals such as oilseed radish and yellow mustard (*Brassica hirta*) typically winter-kill, whereas biennials such as forage kale, forage turnip, and canola regrow in spring. These crops are excellent nitrogen scavengers during the fall, but growers should not allow them to set seed because weed problems may result. Yellow mustard produces a deep taproot that can potentially break up shallow compacted soil layers. Some specific varieties of brassica cover crops may significantly decrease soil-borne plant pathogens if incorporated while plant material is still green (see “Cover Crops and Plant Diseases,” page 7). They may, however, also harbor certain other plant pathogens and nematodes common to related vegetable crops. Brassicas generally require a fairly fine seedbed for good establishment and may be more susceptible to herbicide residues than small grain cover crops. By the following spring the surface residues from oilseed radish and yellow mustard have mostly been lost through decomposition, fragmentation, and blowing winds, but nonetheless they provide excellent winter weed control.

Sudangrass and sorghum-sudan hybrids

Seeding rate: 50 lb./acre

Timing: Late spring–summer

Description: Warm-season annual grasses

Comments: Sudangrass, and the closely related sorghum-sudangrass hybrids, produce very large amounts of biomass

Planning for Cover Crops Leads to Success

Follow these steps for successful cover cropping:

1. Identify and rank the needs to be addressed
 - improve soil structure
 - add organic matter
 - add nitrogen
 - prevent erosion
 - control weeds
 - manage nutrients
 - suppress disease pathogens and nematodes
2. Identify when and where bare land is available for cover cropping
 - time niches: e.g., summer and fall fallow periods
 - space niches: e.g., between rows in a field (intercropping or relay cropping), or between plastic-mulched beds
3. Match the needs and the niches with the most appropriate cover crops
 - Cover crops differ greatly in optimal growing temperatures, cold hardiness, flood and drought tolerance, ability to fix nitrogen, ease of management, speed of decomposition, impact on pest populations, and seed costs.
4. Make a tactical plan of the specific, detailed actions that need to be taken
 - What needs to be done?
 - Who will do it?
 - When will it be done?
 - How will it be done?
 - Post this plan in a conspicuous place so that everyone involved is reminded of the tasks to be performed.



Like all crops, cover crops perform best under good growing conditions. Sudangrass, which has a relatively high nitrogen requirement, grows poorly in a field of low fertility (left).

When a moderate rate of fertilizer is applied before planting, however, sudangrass easily exceeds 8 feet in height (right).

and penetrate compacted soils, especially muck soils. Soil temperatures should be 65° F or higher before planting. Although most growers find these crops to be very productive without supplemental fertilizer, they have responded very well in experimental trials to moderate additions of nitrogen. Seeding after July 15 does not generally allow for adequate growth before frost occurs. Mowing to a height of about 6 to 12 inches once during the season when the crop is 2 to 3 feet high is recommended because it stimulates

prolific tillering, prevents the development of large woody stems that can be difficult to incorporate, and may also stimulate a deeper root system. If left unmowed, they can reach heights of 8 feet or more. If incorporated green sudangrass may suppress some diseases and nematodes (see “Cover Crops and Plant Diseases,” page 7). Sudangrass (e.g., Trudan 8) and sorghum-sudan hybrids (e.g., Sudex) are extremely sensitive to frost. Incorporation before mid-September allows time for the cover crop to decompose, minimizing problems with nitrogen immobilization and excessive surface debris. Among cover crops, sudangrass ranks highest in biomass production, ability to grow on compacted soils, and remediation of compacted soils. Onions, sweet corn, lettuce, carrots, and snap beans have all shown improved yields following one year of sudangrass in Cornell trials.

Buckwheat

Seeding rate: 60–70 lb./acre

Timing: Late spring–summer

Description: Warm-season annual broadleaf

Comments: Buckwheat is a summer cover crop characterized by very rapid growth (it flowers in four to six weeks), moderate biomass accumulation, a fine extensive root system, and the ability to thrive on poor soils. Buckwheat can reseed and become a weed problem if it is allowed to flower and set seed before incorporation. It decomposes relatively quickly after incorporation and is very sensitive to frost. Two successive buckwheat cover crops in summer followed by winter rye can effectively reduce weed pressure in a field. Buckwheat is not particularly effective at root growth into compacted soil layers or remediation of compacted soils, but it may aid soil tilth by improving soil aggregation.

Legumes

Hairy vetch

Seeding rate: 20–40 lb./acre. Drilling is preferable.

Timing: Late August–early September

Description: Annual winter-hardy legume

Comments: Hairy vetch has the potential to supply up to 100 pounds of nitrogen per acre if left to grow well into May. Trials in Massachusetts have demonstrated that sweet corn, broccoli, and peppers can reach top yields relying solely on nitrogen from a previous vetch cover crop. Fall growth is typically modest; most growth occurs in spring. The crop may not always survive winter in some locations. Mixtures of vetch and rye or vetch and oats can increase biomass production and reduce the risks of nitrogen immobilization by the incorporated grain crop the following spring. Incorporate or mow closely at full flowering to maximize nitrogen contribution and to avoid seed set and subsequent weed problems. Alternatively, hairy vetch can be sown in late July and will produce significant biomass

through the fall. Sown this early, hairy vetch will usually winter-kill. Hairy vetch is a host for several plant diseases such as white mold as well as lesion and other plant-pathogenic nematodes. When well established, it suppresses weeds effectively, but it can become a weed problem itself if allowed to go to seed. Vetch does not perform well on poorly drained soils and thus is a poor choice for remediating compacted soils. Lana vetch, a cover crop that is closely related but not winter-hardy, can be used as a summer nitrogen-fixing cover crop.

Red and white clovers

Seeding rate: 10–15 lb./acre

Timing: Very early spring or late summer

Description: Perennial legumes

Comments: Clovers are slow growing and often compete poorly with weeds. Of the clovers, the red varieties are tallest, Ladino white clover is medium in height, and Dutch white



Interseeding storage cabbage with hairy vetch (a) or rye (c) enables a cover crop to be established long before the late fall harvest of the cabbage. The following spring, the strips of both vetch (b) and rye (d) have produced significant biomass, protecting the soil from erosion and adding organic matter. If well established, these cover crops can stand up well to traffic from the cabbage harvest except when fields are very wet.

clover is very low growing. Red clover can be frost seeded into wheat in late winter and can contribute up to 40 pounds of nitrogen per acre after one year's growth. The ability of most clovers to tolerate shade makes them useful for overseeding. Red clover taproots may also be beneficial in breaking up compacted soils. Dutch white clover can be useful for walkways or alleys. Crimson clover, although not winter-hardy, can be used as a summer nitrogen-fixing cover crop.

Annual sweetclover (Hubam)

Seeding rate: 25 lb./acre

Timing: Very early spring

Description: Summer annual legume

Comments: Annual sweetclover can reach 5 to 6 feet in height by early fall. It ranks very high among the legume cover crops in ease and reliability of establishment and biomass production, including growth on compacted soils. Mowing makes incorporation easier and may improve

growth. Weeds and weevils can be problems early in the season, but Hubam usually outcompetes and smothers the weeds by the end of the season. Annual sweetclover will not tolerate low pH.

Biennial sweetclovers (yellow blossom and white)

Seeding rate: 15 lb./acre

Timing: Early spring or late summer

Description: Biennial winter-hardy legumes

Comments: Biennial sweetclovers are characterized by long, thick taproots that may improve soil structure. Biomass production and root growth are generally higher in the second year. Biennial sweetclovers should be plowed down when they are in flower in late June or early July of the second year. Weeds and weevils can be problems early in the season; weed suppression is greater in the second year. Sweetclovers will not tolerate low pH but can withstand low fertility.

Cover Crops for Weed Control

Although the primary benefit of cover crops is to improve or maintain soil quality, they can also help to control weeds. The idea behind a "smother crop" is to replace unpredictable, difficult-to-manage weeds with uniform and more easily managed cover crops. Cover crop residues can also be used to suppress weeds by creating a physical barrier or by releasing chemicals that inhibit weed seed germination and growth.

Summer smother crops

To have a competitive advantage over weeds, smother crops should be established rapidly and uniformly. Doubling or tripling normal seeding rates will help. It is also critical to select cover crops to match the desired timing of planting. Table 1 shows the weed suppressive ability

Table 1: Percent weed suppression six weeks after cover crop planting (from B. Caldwell)

Planting Date	May 26	June 24	July 19	August 14
Buckwheat	92	69	69	69
Japanese millet	91	88	86	89
Sudangrass	84	65	11	38

of three summer smother crops by planting date from informal New York State trials.



Non-winter-hardy cover crops can be grown in the fall and left to form a dead mulch the following spring. Oilseed radish (a) suppresses winter weeds very well compared to the control (c; no fall cover crops) but leaves little residue by April. Oats (b) are less effective at weed suppression but leave much more aboveground residue.

Japanese millet appears to be a good choice for weed suppression in any six-week opening in the summer. For warm, dry soils and longer weed control, sudangrass may be a better choice. For shorter openings, buckwheat works well. In trials in Massachusetts, two plantings of buckwheat (sown in early June and late July at 84 kg/ha) followed by winter rye (sown at 126 kg/ha in September) were extremely effective at reducing weeds for a subsequent lettuce crop. Such a system has the advantage of combining tillage with continuous cover crop competition for weed control.



Pumpkins can be no-till planted into an herbicide-killed rye cover crop for annual weed suppression. The rye mulch can facilitate walking in pick-your-own pumpkin fields and minimizes dirt and mud on the pumpkins. This system requires careful planting and is not appropriate in fields that have perennial weed infestations.

Winter Annual Cover Crop Residues

For weed-suppressing residues, the more aboveground biomass, the better. Rye and wheat residue of 3,500 to 4,000 pounds per acre can usually suppress most weeds adequately for up to 12 weeks in no-till systems. Some growers report very good weed control in fields where pumpkins are no-till planted into herbicide-killed rye mulch. For fields dominated by perennials or large-seeded annuals such as velvetleaf, more residues than can practically be produced under northeastern growing conditions are required for good weed control. In these cases, the use of cover crop residues can be supplemented by herbicides or hand weeding.

Cruciferous cover crop residues can suppress weeds through release of allelochemicals as well as through competition. Experiments in New York have shown that oilseed radish, white senf mustard, and yellow mustard planted in late August and winter-killed in December provided excellent weed suppression through early spring. Attempts to extend the weed-suppressive ability of crucifers by planting them in the early spring before corn planting are being explored.

Intercropping with Cover Crops

Cash crops can be planted into established cover crops, or cover crops can be interseeded into established cash crops to help suppress weeds. In either case, it is important to avoid yield-reducing competition between the two crops. Several approaches have been successful:

- Suppress established cover crops by applying herbicides, rototilling, or covering them with black plastic before the cash crop is planted.
- Select cover crops that complement the growth habit of the crop. For example, short, shade-tolerant cover crops such as red clover can be grown under the canopy of taller crops.
- Plant cover crops after crops are well enough established to withstand competition. For example, interseeding hairy vetch into cabbage 30 days after transplanting may be sufficient to avoid reduced yields while contributing to late-season weed suppression.

Cover crops will generally be less effective in fields dominated by perennials such as quackgrass or Canada thistle. They will also generally require complementary weed control methods such as tillage or herbicides for satisfactory weed control.

Cover Crops and Plant Diseases: A Double-Edged Sword

Cover crops can have both beneficial and detrimental effects on vegetable diseases. Although the use of a cover crop can often suppress plant diseases by breaking disease life cycles, increasing soil microbial activity, or creating a better environment for root growth, in some cases specific cover crops may make plant diseases worse. Ideally, a cover crop should suppress target pathogens or at least be a non-host or poor host. Although the interactions between cover crops, vegetable crops, and plant pathogens are complex and not yet completely understood, recent research has produced the following findings:

- Root rots in snap and dry beans are generally reduced after the incorporation of oats, ryegrass, rye grain, barley, wheat, and sudangrass. When beans are planted in soils that have remained wet following incorporation of a rye cover crop, however, reduced stands and increased severity of root rot may occur. Waiting up to four weeks between incorporation and planting improved growth and reduced severity of root rot.
- Cover crops differ greatly in their ability to host plant pathogenic nematodes. Lesion nematodes (*Pratylenchus* spp.) are widely distributed and attack most vegetable crops grown in northeastern production areas. In greenhouse studies, lesion nematodes increased their populations by a factor of six in pots containing hairy vetch. In contrast, populations decreased in pots containing ryegrass. Beans grown in pots following vetch, alfalfa, white clover, and rye grain had relatively high populations of lesion nematodes, whereas beans grown in pots following sudangrass, canola, and ryegrass had low nematode populations.
- Certain strains of brassica cover crops that contain high concentrations of antifungal glucosinolates may become a useful tool in managing soil-borne pathogens in vegetables. In one study, *Brassica juncea* cv. Forge decreased severity of bean root rot from 55 percent in controls to 33 percent of the affected root area. In a laboratory bioassay this species suppressed *Fusarium* dry rot of potatoes.
- Populations of root-knot nematode (*Meloidogyne hapla*) were suppressed and lettuce yields improved when sudangrass was green-chopped and incorporated into nematode-infested soils that were subsequently planted to lettuce. This nematode attacks lettuce, onions, carrots, beans, beets, peas, and tomatoes. Sudangrass grown for one to two months and then incorporated green before a frost was found to be most effective. Nematode suppression by sudangrass may result from the production of cyanogenic compounds during decomposition.

Cover Cropping Practices of New York Vegetable Growers

Commercial vegetable growers in six western New York counties were surveyed in the fall of 1997 to determine what cover cropping practices they were using. Out of 315 surveys sent out, 118 responses, representing 37,093 acres of vegetable production, were returned. Individual operations ranged from 1 to 4,000 acres and produced a wide variety of vegetables, including onions, potatoes, sweet corn, snap beans, peas, dry beans, cabbage, vine crops, tomatoes, peppers, leafy greens, beets, and carrots.

Respondents grew cover crops on a total of 15,426 acres. Oats, rye, clovers, and wheat were the most commonly used cover crops, but several growers also planted barley, sudangrass, and ryegrass. A small number of growers used buckwheat or rye and hairy vetch. Most cover crops were planted in September and October, except for clovers (March and April) and sudangrass and buckwheat (June and July).

Forty-six percent of respondents considered erosion control to be the most important benefit of cover cropping; 42 percent said addition of organic matter was the most important benefit. Other reported benefits included weed control, adding or conserving nutrients, improving soil tilth, reducing soil compaction, and reducing insect and disease pressure. The major problems of cover cropping identified in the survey included interference with spring fieldwork or fall harvest; difficulties with incorporating cover crops; and cost in labor, materials, or equipment. Several growers mentioned incompatibility with herbicides used in the cash crop and weed control problems in the cover crops themselves.



Sudangrass produces the greatest biomass of summer-grown cover crops and should be mowed at least once during the season. Onion growers are finding that rotation with sudangrass improves yield and quality on muck soils.

Cover crops protect and improve the soil, but using them in vegetable production systems presents challenges. This publication helps commercial growers turn challenges into benefits.

For cover cropping to be successful, the grower must

- know the intended purpose(s).
- consider important management factors.
- understand the characteristics of different cover crop species.

This 12-page information bulletin suggests cover crops and presents the latest research on varieties and procedures to reap the benefits including

- the addition of organic matter to soils.
- improvement of soil tilth and repairing compacted soils.
- protection of soil from wind and water erosion.
- recycling of plant nutrients.
- increase in the biological activity of soil.
- retention of soil moisture.
- suppression of weeds, insects, pathogens, and nematodes.