

Table 4. Typical carbon-to-nitrogen ratios.

Material	Carbon:Nitrogen Ratio
Legume hay	15-19:1
Non-legume hay	24-41:1
Corn stalks	42:1
Oat straw	70:1
Rye straw	82:1
Cow manure	18:1
Finished compost	17-20:1
Agricultural soils	8-14:1
Hardwood sawdust	500:1

for nitrogen. Microbes have a requirement of about one nitrogen atom for each 25 carbon atoms. This is a carbon-to-nitrogen ratio (C:N) of 25:1 or 25. If the organic matter has a higher C:N (more C and less N), microbes will need more nitrogen and will take it from the soil. Microbes are more efficient than crops in obtaining nitrogen from the soil. If there is not enough nitrogen for both the microbes and the crop, the crop will not obtain what it needs. Eventually there will be a net gain in nitrogen, but crops can suffer in the short term. If organic matter with a high C:N is applied to soil shortly before planting a crop, additional nitrogen may be needed to assure the needs of both the microbe and the crop are met. Organic matter with a C:N of less than 25:1 (25) should not be a problem and in some cases can contribute nitrogen for crop use. See Table 5 for examples of C:Ns of some sources of organic matter.

Cover Crops and Green Manures

Cover crops are grown to protect and/or enrich the soil rather than for short term economic gain. When turned into the soil, a cover crop is called a green manure, so the terms are reasonably interchangeable.

When a cash crop is not growing, it is wise to sow something to protect the soil from wind and water erosion, thus the term cover crop. It is also wise to “rest” your fields by occasionally rotating out of cash crop production, while at the same time growing something to improve soil fertility, thus the term green manure. Some green manure crops can also suppress weeds, by “smothering” them and starving them for light. Use high seeding rates if cover crops are grown for weed suppression.

Depending on their growing requirements, cover crops can be sown after vegetable harvest, between a

spring and fall crop or by overseeding into a standing small fruit crop after a final cultivation.

In selecting a green manure crop, consider the following: seed cost, winter hardiness (if applicable), ability to fix nitrogen, suppress weeds, and suitability to soil conditions, tillage equipment and the crop to follow. Here is a list of some common cover crops in New England and a description of their uses.

NONLEGUMES

These are selected when nitrogen contribution to the soil is not a priority. They tend to grow more rapidly and thus are better at short-term weed suppression than legumes. Late-season grasses are useful for recovering leftover nitrogen after crops have been harvested.

Winter Rye is a common winter cover crop, sown after cash crops are harvested in the fall. It is very hardy, adapted to a wide range of conditions, and seed is inexpensive. The latest-sown cover crop, it produces a lot of biomass in the spring. This adds organic matter to the soil but may be difficult to incorporate prior to crop planting.

Oats are used as a winter cover crop to protect the soil without requiring intensive management in the spring, because they are frost-killed. Shallow incorporation of residues may still be necessary before crop planting. Enough growth is needed before first frost to adequately protect the soil, so plant by late August, at a rate of about 100 lb/acre. Oat residues left on the soil surface may chemically suppress weed growth, and act as a physical barrier. Oats are also a good cover crop to plant any time during the spring or summer when land is out of production. Unlike winter rye, oats grow vigorously and upright when seeded in the spring or summer and compete effectively with weeds. Can grow in soils with low pH (5.5).

Ryegrass is a low-growing cover crop that produces an extensive root system good at capturing leftover nitrogen. It is well suited to undersowing, after last cultivation of a cash crop, in order to establish a winter cover prior to harvest. Annual ryegrass is less expensive than perennial ryegrass, and is more likely to winterkill; however, it may overwinter in milder areas, and perennial ryegrass may winterkill in harsher zones. These crops form a dense sod that reduces erosion.

Sudangrass and Sorghum-sudangrass (Sudex) are fast-growing, warm season crops that

Table 5. Pre-plant cover-crop seeding dates and rates.

Cover Crop	Recommended Seeding Dates	Seeding Rate
Alfalfa	Early April to late May or Late July to mid August	14 - 20 lbs/A
Buckwheat	Late May to early June or Late July to early August	60 - 75 lbs/A
Clovers (Alsike, Ladino, White)	Early April to late May or Late July to mid August	4 lbs/A (alsike and white) 2 lbs/A (ladino)
Red Clover	Early April to late May or Late July to mid August	8 - 10 lbs/A
Sweet Clover	Early April to mid May or Early August	12 - 20 lbs/A
Hairy Vetch	August to early Sept.	30 - 40 lbs/A
Annual Field Brome	July and August	20 lbs/A
Japanese Millet	Late May to mid July	20 lbs/A
Spring Oats	Early to mid April or Mid August	100 lbs/A
Annual Ryegrass	Early April to early June or Early August to early Sept.	30 lbs/A
Perennial Ryegrass	August to mid Sept.	25 lbs/A
Winter Rye	August to mid Sept.	80-100 lbs/A
Sudan Grass	Late May to Early June	80 lbs/A
Sorghum-Sudan Grass Hybrids	Late May to Early June	35-50 lbs/A

require good fertility and moisture to perform well. Under such conditions, their tall, rank growth provides excellent weed suppression. Such heavy growth can be difficult to cut and incorporate. Due to its growth habit, sudan grass should be cut back when growth exceeds 20-25 inches or plowed down if a second growth is not desired.

Buckwheat is a fast-growing summer annual that can be used to protect the soil and suppress weeds for a month or two between spring and fall cash crops. It grows fairly well on acid and low phosphorus soils. It decomposes rapidly, so is easy to incorporate, but does not contribute a lot of organic matter to the soil. Mow or incorporate at flowering, prior to setting seed so it does not become a weed in subsequent crops. Grows well in low soil pH. To smother weedy fields, some growers plant two successive crops of buckwheat followed by winter rye. Do not allow buckwheat to go to seed prior to plow-down.

Annual Field Brome: Winter annual grass. Establishes rapidly and has extensive fibrous root system contributing organic matter to soil. Plow down in spring. Seed not readily available so plan ahead.

Japanese Millet: Summer annual grass. Fast growing and competes well with weeds. Establishes faster than sudan grass on cool soils. Can be cut back and allowed to regrow after reaches 20 inches. Can reach 4 ft. in 7-8 weeks. Do not allow to mature and drop seed.

LEGUMES

Sown when “free” nitrogen is desired for a subsequent cash crop with a high nitrogen demand. Legumes generally require good drainage and fertility. Most grow slowly at first so they do not compete much with weeds until well established. Drill seed for best stands. Mix seed with proper inoculant to insure nodulation. Often sown with a nurse crop such as oats, or in mixes with perennial grasses. When legumes are mowed, tarnished plant bugs may be driven into adjacent crops, such as strawberries or raspberries increasing the likelihood of damage.

Red Clover is a short-lived perennial that is somewhat tolerant of acid or poorly drained soils. Mammoth red clover produces more biomass for plow-down than medium red clover, but does not regrow as well after mowing. Mammoth will often establish better than medium in dry or acid soils. Sow in early spring or late summer.

White Clover is a low-growing perennial, tolerant of shade and slightly acid soil. Ladino types are taller than the Dutch or wild types. White clover is a poor competitor with weeds unless mowed. Suitable for use in walkways or alleys. Expensive seed.

Sweetclover is a biennial (except for annual types like Hubam) that is deep-rooted and adapted to a wide range of soils. It is a good soil-improving crop with a strong taproot that opens up subsoil. Yellow sweetclover is earlier maturing and somewhat less productive than white sweetclover. Sow in

early spring or late summer at 15 to 20 lb/acre. Heavy growth is produced in spring after overwintering. Incorporate in late spring or mid-summer at flowering. May deplete soil of moisture, which can be a problem for subsequent crops in dry years.

Hairy Vetch has become increasingly popular as a cover crop. It can fix tremendous amounts of nitrogen. Generally this cover crop is seeded in the fall after August 15 or before mid-September in most areas. It should be allowed to grow at least until mid-May before plowdown. It is advisable to seed winter rye (30-40 lbs/acre) or oats (40-50 lbs/acre) with the vetch when seeded in the fall to take up unused nitrogen and to ensure a good ground cover for erosion control. Most growers prefer oats to winter rye because the oat will not overwinter and the vetch alone is easier to manage the following spring. Hairy vetch can also be seeded in early spring or summer. When seeded in early April it will produce significant nitrogen in time for a late seeding of sweet corn or brassica. When seeded in the summer it will usually winter kill and the following spring the nitrogen will become available for an early crop. Treat seed with a pea-type inoculant.

Alfalfa requires deep, well-drained soil with a pH near neutral for good growth. It is a long-lived perennial that is probably not worth the expense in a short-term rotation. Fixes large amounts of nitrogen if maintained for several years. Seed early spring or late summer at 15 to 25 lb/acre.

Mixtures

Legumes and grasses are often mixed as cover crops to hedge against failure of one and to get some of the benefits of both. The grass will usually establish quickly, holding soil in place and “nursing” the legume along. By taking available soil N, the grass promotes N-fixation by the legume. Fertilization with N or the absence of mowing favors growth of grass over legume. Some common mixtures, in addition to vetch and rye described above, are red clover and oats (combine or mow oat heads, leaving established clover); ryegrass and white clover for mowed alleys. Timothy is often used as a nurse crop for alfalfa. It is advisable to trial unfamiliar cover crops or mixtures on a small scale to determine if they are suited to your climate and management resources before growing them widely.

Note: N fixed in root nodules moves to the

leaves and stems of legumes. If hay is harvested from the field prior to plowing, very little N will be contributed to the subsequent crop.

Guidelines for Organic Fertilization

Soil fertility is a function of the biological, physical and chemical characteristics of soil. An organic fertility program should consider all of these interrelated factors in order to optimize and sustain crop production.

Soil tests are useful for monitoring soil organic matter content, which influences the physical and biological quality of soil. Soil tests also estimate the level of chemical nutrients in the soil that are available to plants. This helps determine the quantity and type of soil amendments needed for good crop yields.

Organic Matter management is an essential part of organic agriculture. Generous additions of compost, animal or green manures are needed to fuel soil microbes, the by-products of which bind soil particles together to improve the physical condition, or structure of soil. Good structure promotes root growth and thus enhances plant retrieval of soil nutrients.

Decaying organic matter releases a slow, steady supply of nutrients to a crop so long as soil temperature, moisture, and aeration support microbial activity (as when soil is properly drained and well warmed). When this release of nutrients, or mineralization, is low, as when soils are cool, fertilizing with soluble forms of nutrients may benefit crops. This is why some soluble phosphorus (P) and nitrogen (N) should be banded, or placed near the roots of crops early in the growing season. For example, use bone meal and dried blood to provide soluble P and N, respectively, or use a commercial organic fertilizer blend. Check with your local Organic Certification organization or Extension specialist for information on the nutrient content of various organic fertilizer sources.

Nitrogen Up to half the N contained in manures and immature compost can become available to plants during the season following incorporation. Each ton of compost containing 1% N can provide a crop with 5 to 10 lb of N per acre. Similarly, there is a release of about 20 lb/acre or more of N for each 1% soil organic matter. These releases of N vary