Garden Soil Management

by Henry G. Taber and Linda Naeve

Natural soils differ in an infinite variety of characteristics. There are thousands of individual kinds, each different from others in color, depth, size, and arrangement of the individual sand, silt, and clay particles, mineral composition, and content of organic matter.

Most soils in Iowa will grow good vegetables, but a few may have special problems needing correction before planting. Some are too wet (poor internal water drainage), others are difficult to till (high clay content), and a few dry out too quickly (light sand).

Tillage

Unless there is serious danger of water or wind erosion, fall is the best time to plow or spade the garden soil. Fall tillage will help control certain insects and diseases that overwinter on the plant refuse.
Fall prepared soils will be subjected to the early spring freezing and thawing action that will help improve the tilth and general soil aggregation. Also, the soils will dry out and warm up quicker in the spring.

The soil should never be worked when too wet. If worked under wet conditions, the soil will become hard and restrict root growth, causing unproductive plants. If a handful of soil formed into a ball crumbles when pressed with the thumb, it is ready for plowing or spading. If the ball of soil retains its shape, delay soil tillage until the water content diminishes.

The soil contains too much water if it will not crumble when pressed lightly with the thumb.

If a ball of soil crumbles when pressed lightly with the thumb, it is dry enough to till.

Organic Matter

A good garden soil should be high in organic matter. As crops are grown, the organic matter level of the soil becomes progressively lower unless organic materials are applied. Remember that commercial fertilizers are not a substitute for organic matter—both are needed for fertile, productive garden soil.

The soil organic matter, or humus, is the dark brown to black substance in the surface layer of soil made up of organic compounds resulting from decomposition of vegetative and animal matter. Manure, compost, and other organic residues have several advantages. They

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• improve the soil physical condition or structure, thereby increasing the tilth or ease of working (this is especially true of soils that tend to pack badly or crust over);

• increase permeability to water;

• increase aeration, allowing increased oxygen supply to roots; and

• increase nitrogen and other nutrient retention, and aid soil microorganism population.

A fine seedbed is needed for the smaller vegetable seeds, such as carrot, radish, and onion.

The use of well-rotted animal manure provides a method of maintaining soil organic matter. Dry and pulverized manure also serves the purpose well and is usually more readily available in towns and cities as are processed sewage sludge, compost made from tree leaves, lawn clippings, garden refuse, and other organic residues. When other organic matter materials are not available, a fast growing, green manure crop may be grown and worked into the soil before the heading stage of growth.

Buying or hauling manures, waste hay, etc., from barns, feedlots, or fields may add some new kinds of weeds to your garden. Some commercially composted materials and processed manures available on the market are treated to kill weed seeds. Mixing undecayed, coarse plant materials, such as straw with manure, cornstalks, waste hay, straw, or cover crops, uniformly into the soil can be a problem to the gardener without power tools. Rotary cultivators and discs can do the job. Putting coarse material through a power grinder-shredder makes it much easier to work into the soil with hand tools, but grinder-shredders do not work well with wet, limp materials. Where a grinder-shredder is not available, a lawn mower can be used to cut up more tender materials such as cornstalks.

Animal Manures

Manures are a good source of humus and plant food if there is not too much litter (straw, sawdust, or shavings) mixed in, and if they have not been stored outside where heavy rains wash out the nutrients. Poultry or rabbit droppings taken from beneath roosts or hutches are high in nitrogen. They actually may burn plant roots if used too generously.

The following table gives the percent of available nutrient content in undiluted animal and poultry excrement. The value of manure as plant food depends on the extent to which it has been diluted or leached by water and the proportion of bedding, such as straw, sawdust, or shavings, that is mixed in it.

Animal	(N) Nitrogen	(P_2O_5) Phosphorus	(K_2O) Potassium
Undiluted excrement	Percent	Percent	Percent
Poultry	1.30	1.17	0.48
Goat	1.03	1.20	1.50
Cow	0.60	0.15	0.45
Hog	0.50	0.35	0.40
Horse	0.70	0.25	0.55
Sheep	0.95	0.35	1.00
Rabbit	1.10	1.50	0.47

Apply barnyard manure at the rate of 500 to 1,000 pounds for each 1,000 square feet of garden area. This is equivalent to 10 to 20 tons per acre. Most manures are short on phosphorus in comparison to nitrogen and potassium, and it is desirable to plow or spade under some phosphate fertilizer at the same time. Use 15 pounds of a 0-46-0 (superphosphate) fertilizer per ton of manure or use a high phosphate commercial fertilizer mix. Since poultry, rabbit, goat, and sheep manure are higher in nutrient content, cut back the

rate of application to 200 to 400 pounds for each 1,000 square feet of area.

Green Manure Crops

Green manure crops are excellent soil builders and will supply satisfactory amounts of organic matter.

Rye or wheat seeded at the rate of 3 to 4 pounds per 1,000 square feet, or annual ryegrass at 2 to 4 pounds may be used. Seed sown near the end of August will normally make sufficient growth before cold weather. If soil erosion is a problem, rye could serve as a winter cover crop and be turned under the following spring before heading.

Compost

Compost can be a good source of humus and a good way of getting rid of a lot of plant refuse from the yard or garden. It should be understood, however, that improper composting will not kill many weed seeds, disease organisms, or underground stems or roots of such plants as quackgrass, morning glory, iris, or bulbs. If you are having disease troubles with certain kinds of plants in your yard, keep those plants out of the compost. Be sure not to add garbage or other kitchen waste to the pile because rotting food attracts rodents. Ask your County Extension Office for Pm-683, *Compost for the Garden,* for further information.

Sewage Sludge

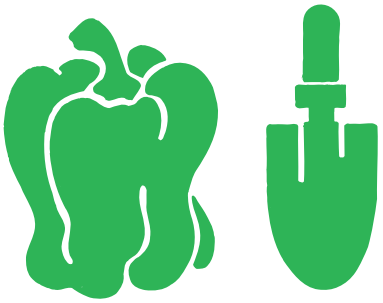
Two different types of sewage disposal systems are commonly used. These are (1) digested sludge by primary treatment with anaerobic digestion, and (2) systems activated by injection of air. Digested sludge is usually of relatively low quality as a fertilizer compared with products from an activated system. Dried, activated sludge, properly heat treated, normally commands a good price on fertilizer markets. Digested sludge, on the other hand, is often available without cost or at a low price.

Activated sludges are widely used as fertilizers for lawns and golf courses. Heat treated sludges are normally safe for use from a sanitary standpoint. Digested sludge, not heat treated, should be used with some caution. Check with your local health department for specifics under which sludges that are not heat treated may be used as garden fertilizers.

The plant food content of sewage sludge is variable. The following figures show the range within which most sludges will fall.

Process	(N) Nitrogen	(P_2O_5) Phosphorus	(K_2O) Potassium	
	Percent	Percent	Percent	pH
Activated	5-6	3-7	under 1	4.5-5.5
Digested	1-3	½-4	under ½	5.5-7.0

The importance or value of minor elements in sewage sludges has not been fully determined.



Sawdust and Mulches

Other materials also supply organic matter. Tree leaves are excellent, as are lawn clippings, peat, sawdust, straw, and spoiled hay and silage.

Sawdust may be mixed with garden soil, whether fresh or weathered. Fresh sawdust will last longer than old sawdust when used as a mulch and will make soils somewhat lighter or more retentive of moisture when plowed under. Old or rotted sawdust will become humus more readily and is less likely to cause nitrogen deficiency. When mixing sawdust with soil, it is best not to work in more than 2 inches of sawdust per year. It should be mixed thoroughly with 6 inches of soil.

A cubic yard of sawdust will cover 300 square feet 1 inch deep. A bushel will cover 15 square feet 1 inch deep.

Whenever a sizable quantity of sawdust or other coarse fibrous material is added to soil, extra nitrogen must be applied with it. Most of the materials are high in carbohydrates (cellulose) and low in nitrogen. Soil microorganisms cannot get enough nitrogen from these materials to adequately break them down into humus, so they absorb additional nitrogen from soil reserves. In fact, so much soil nitrogen is "tied up" in bacterial action that garden plants next spring will be cut short and experience a nitrogen deficiency, evidenced by yellowing and stunting of growth. This is the most common problem facing users of organic mulches and sawdust.

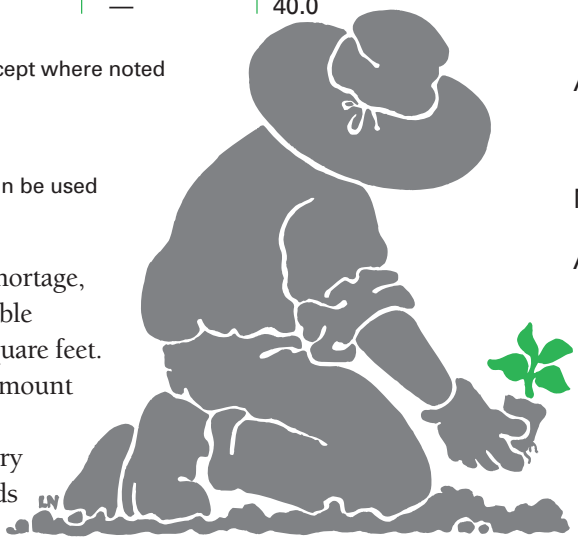
Some organic materials contain substantial amounts of plant food elements whereas others contain very little. Selection of a product high in nitrogen content will assist soil microorganisms in decomposition.

Material	(N) Nitrogen	(P_2O_5) Phosphorus	(K_2O) Potassium
	Percent	Percent	Percent
Alfalfa hay	2.45	0.50	2.10
Alfalfa straw	1.50	0.30	1.50
Grass hay	1.20	0.35	1.75
Clover hay	2.10	0.50	2.00
Pea vines*	2.08	0.60	2.00
Oats*	1.50	0.65	2.20
Rye*	2.00	0.80	2.80
Wheat*	2.14	0.20	2.48
Wheat straw	0.50	0.15	0.60
Wood ashes	0.00	1.75	6.00
Coal ashes**	—	—	—
Corn cob ashes	—	—	40.0

Based on dry weight except where noted for green forage.

*Green forage
**No fertilizer value—can be used to loosen up clay soils

To avoid a nitrogen shortage, use 1 pound of available nitrogen per 1,000 square feet. You can supply this amount by using a manure (100 pounds of poultry manure or 200 pounds of cow, hog, or steer manure, not containing bedding material) or a commercial fertilizer. Apply 10-10-10, 12-12-12, or other similar complete commercial fertilizer at the rate of 8 to 10 pounds per 1,000 square feet.

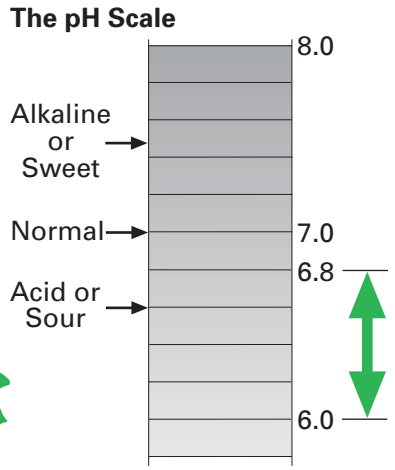


Fall is the preferred time to plow or spade under organic matter. This allows partial decomposition of the material, and it is quickly available the following growing season. It is always wise to watch plant growth closely when large quantities of sawdust have been used. Slow growing plants with small, pale, green or yellowish leaves usually mean that the plants need more nitrogen. A side dressing later in the growing season may be necessary.

Soil pH

Soil pH, a measure of soil acidity, is important in maintaining a supply of calcium and minor elements. A soil pH of 7.0 is neutral, while a pH above 7.1 is alkaline or basic. Most Iowa soils are neutral or slightly alkaline. Most vegetables grow best on a slightly acid soil in the range of pH 6.0 to 6.8. Minor or trace elements, such as manganese and boron, are not likely to be a problem if the pH is within this range.

The growth appearance of your crop is the best guide to adequate pH levels. If a few or all of your vegetable crops are not growing well or if your garden space is on new ground, then a pH test may be necessary. If a pH test indicates a low soil pH, liming is necessary. Only a small percentage of Iowa soils require liming. It is unwise to



A soil pH level of 6.0 to 6.8 (slightly acid) is the best range for most vegetables.

assume that lime is needed since overliming can cause damage. The only way to determine the lime requirement is by soil analysis.

When a soil test indicates lime is needed, the material can be applied either in the fall or in the spring. The soil test will indicate the necessary amount to apply per 1,000 square feet. It is important to apply lime before plowing or deep disking since it should be mixed with the soil to be most effective. If ground limestone can be obtained, it should be applied in preference to hydrated lime. Ground limestone will be available over a longer period and usually costs less than hydrated lime.

Commercial Fertilizer

Commercial fertilizers are effective and economical for supplying some of the mineral elements used by plants. Home vegetable gardens are not usually large. For a few dollars, enough fertilizer can be applied to bring soil nutrient level up for vigorous crop growth. But it must be remembered that it is possible to apply too much fertilizer, which can be just as undesirable as too little.

There are many kinds and grades of fertilizer that can be used on gardens. By law, all commercial fertilizers, including specialty fertilizers (such as organics) must state the guaranteed analysis on the bag; that is, the percentage of nitrogen (N), phosphorus (as P_2O_5), and potassium (as K_2O)—always in that order. For example, a 6-10-4 fertilizer contains 6 percent available nitrogen, 10 percent available phosphoric acid, and 4 percent available potash. Other analyses might be 10-10-10, 12-12-12, or 5-10-10, to mention only a few. As a rule, those with the higher numbers are more economical to use since the cost per unit of actual nutrient is lower.

Several other elements are necessary for plant growth. These are called the minor or trace elements. Iron, boron, manganese, and zinc, as well as others, are in this class. Most Iowa soils contain sufficient amounts of the trace elements, and it is only in rare instances that separate applications of these materials are needed. Many of the commonly used commercial fertilizers contain the trace elements as impurities. Animal manures also contain a number of trace elements.

The percentage of fertilizer elements will always appear in this order on the bag (nitrogen, phosphorus, potassium).

Soil Tests

Soil tests carried out by Iowa State University's Soil Testing Laboratory are available to gardeners as well as commercial growers. Your County Extension Office has shipping boxes, directions for taking samples, and information sheets that should be sent in with the samples. The general soil test includes determinants for soil acidity or soil pH, phosphorus, and potassium. Special tests for organic matter, zinc, and sulfur also are available. There is a small fee for the test and mailing.

Soil in yards is often shifted around as lots are leveled or graded, basements are dug, and driveways and walks are put in. If you take a sample for a soil test, be sure it represents an area that is fairly uniform in color and texture. If there is noticeable difference in parts of your yard, or the part you want tested, separate samples may be worthwhile. After the test is completed, you will receive recommendations for fertilizer application.

How Much Fertilizer to Use

The rate of fertilizer to apply will vary depending on past fertilizer use, crops grown, soil type, and other factors. However, it is usually safe to apply a low analysis fertilizer, such as 5-10-5 or 6-10-4, annually at the rate of 20 to 30 pounds to each 1,000 square feet. Fertilizers of higher analysis, such as 6-24-24, 12-24-12, or 12-12-12, may be applied at half the above rate. If scales are not available the material can be measured. One pint weighs approximately 1 pound.

If manure has been used at the rate of 500 pounds or more per 1,000 square feet, reduce the rates by one-half.

Caution: If there are large quantities of straw, sawdust, or shavings mixed in with the manure, the growth promoting effects of the manure nitrogen may be reduced. Extra nitrogen may be needed in the general fertilizer program or as a side dressing during the growing season. Weak growth and pale green leaves are often evidence of too little nitrogen available to the plants. If the plants need extra nitrogen, use about 2 to 3 pounds of actual nitrogen per 1,000 square feet of garden area.

Many home lawn garden centers stock separate nitrogen sources in small convenient packages. Use one of the following nitrogen sources:

Nitrogen Source	Lb./100 ft. of Linear Row
Ammonium nitrate (34-0-0)	⅓ to ¾
Ammonium sulfate (21-0-0)	¾ to 1¼
Urea (45-0-0)	¼ to ½

Apply side dressed fertilizer along the row about 30 days after crop emergence.

Be sure to irrigate or rake in the fertilizer band to move the nitrogen below the soil surface.

The most efficient method of application is by side dressing. Apply the lower amount to closely spaced rows, such as carrots, beets, lettuce, etc. Use the larger amount for wider spaced rows, such as tomatoes, corn, potatoes, etc.

To apply the side dressing, spread the fertilizer evenly along the row in a 3- to 4-inch wide band. Rake it in below the soil surface or irrigate with an inch or more of water.

Many garden crops respond to additional fertilizer applications later on in the season. Cucumber, squash, broccoli, cabbage, and others can be fertilized by side dressed applications a month or 6 weeks after planting. About 2 tablespoons of a com-

plete fertilizer around each plant should be enough. Tomato yields may be increased by side dressing, but the fertilizer should not be applied until the first cluster of fruit has set. Overfertilization of any garden crop may cause the plant to make excessive vegetative growth at the expense of fruit set.

Liquid Starter Fertilizers

Fertilizer in liquid form is often used at transplanting time. Completely soluble, high analysis materials are available for this purpose. Such fertilizers should not be applied in dry form but should be dissolved in water before application. Follow the directions on the container when using these materials.

Complete fertilizers may also be used for the liquid starter application. Use low analysis materials at 2 tablespoons per gallon of water or high analysis at 1 tablespoon per gallon.

Liquid starter fertilizers are used at the time plants are being transplanted to the garden. After planting, apply ½ to 1 pint around each plant.

You can make your own liquid starter solution for transplants by adding 2 tablespoons of any commercial analysis fertilizer per gallon of water.

Add the starter solution to the transplant at the rate of 1 pint per plant.

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