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Fertilizing Gardens in South Dakota

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Gardens can provide high quality vegetables, fruits, and flowers if the crops are given adequate nutrients and water and insect, weed, and disease control. This fertilizer guide covers part of your garden's needs—optimum nutrients for yield and quality of garden plants.

SOIL TESTING

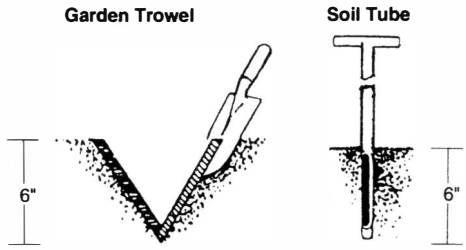
Soils of South Dakota in general are very high in native fertility. Over thousands of years, the native prairies accumulated plant nutrients in the soil organic matter. With plowing, farming, and grazing, some of these nutrients have been removed by plants and livestock or lost by erosion. Some nutrients have been replaced by added fertilizers, compost, or manures.

To ascertain the current fertility status of the soil in your garden, it needs to be tested. Soil testing begins by taking a soil sample.

Taking a sample

The depth of the soil sample should be approximately the depth of tillage, usually around 6 inches. This represents the soil in the 0–6-inch depth of your garden.

First, scrape away or discard any surface litter.Use a garden trowel, spade, or sampling tube to take your sample. Put the sample (a slice or core about 1-inch thick) in a clean container. Repeat this sampling procedure in 10 spots within the garden, adding the samples to the original container. Mix well the soil from all samples to make a composite (mixed) sample. Take out about one pint and label for identification purposes.



One composite sample should be taken for each garden or flower bed. If an area exists in your garden that produces poor plant growth, keep the soil from it separate from the other samples; soil fertility, pH, or salts may be the problem there.

Avoid (or sample separately) trouble spots or unusual areas such as borders, low spots, pet runs, along foundations, etc. Lawn areas should be sampled separately from gardens.

If samples are wet, dry by spreading them on clean paper and letting the air dry the soil (do not heat) before placing in mailing containers.

When to sample

Soil samples may be taken any time of the year. However, if the soil is frozen or too wet, obtaining a good sample will be very difficult. Many samples are taken in the fall or early spring to determine nutrient needs for the upcoming season. If a problem surfaces, a sample can be taken during the growing season as well.

Submitting samples

For analysis at the SDSU Soil Testing Laboratory, fill out the soil sample information sheet and enclose it with the soil sample in a sturdy mailing container. Forms, fees, and soil bags are available from your local SDSU Extension office. The form, fees, and sampling guidelines can also be found and printed from the SDSU Soil Testing website at: http://www.sdstate.edu/ps/soil-lab.

For the vast majority of South Dakota soils, the "regular series" tests will be sufficient. This series includes organic matter, nitrogen, phosphorus, potassium, pH, soluble salts, and texture. Other nutrient tests are also available.

Send sample(s) to:

Soil Testing Laboratory
Box 2207A, Ag Hall 306
South Dakota State University
Brookings, SD 57007-1096
Telephone: (605)688-4766
Web: http://www.sdstate.edu/ps/soil-lab

The samples can also be delivered in person to Room 306, Agricultural Hall (north door, corner of 11th St. and Medary Ave.) on the SDSU campus.

Include payment along with state and city sales tax. Alternatively, a bill can be sent with the test results. Allow 5–8 days for sample delivery to the lab, processing, and mailing of the results.

FERTILIZERS

Plants require 16 essential nutrients with 13 of these coming from the soil. Fortunately, most of our South Dakota soils have most of these in abundance.

The most common limiting nutrients of our soils (in order) are nitrogen (N), phosphorus (P), potassium (K), sulfur (S), and zinc (Zn). Once the soil test is complete, the returned recommendation will tell you what nutrients are needed for your garden and how much to apply. The choice of the nutrient source (fertilizer) is yours.

In general, N and P are needed on many soils of South Dakota, and K is needed only on some soils in eastern South Dakota or on very sandy soils. For most soils that have been used for gardens for a number of years, P and K tend to be adequate for plant needs.

Most South Dakota soils are high in S and Zn. However, if you are beginning a garden in a new area or have added significant amounts of new soil you may want to check for S and Zn along with the regular soil test series.

Commercial inorganic fertilizers

The advantages of commercial inorganic materials are that they are readily available, easy to apply, and can be applied to exactly meet your garden's particular nutrient needs. A disadvantage is that many fertilizers contain more than one nutrient (mixed forms). If commercial fertilizers can't be found with only the nutrients that are recommended for your garden, the risk of over-fertilization becomes a disadvantage similar to that of organic fertilizers.

The content of N, P, and K is stated on the fertilizer bag. Therefore a 15-10-5 fertilizer contains 15% nitrogen, 10% phosphate (P_2O_5) and 5% potash (K_2O) by weight. (Any other nutrient present will also be listed on the fertilizer bag.) These numbers are called the fertilizer analysis and are always listed in the order of N, P, and K.

To calculate the amount of fertilizer needed for a given area, the amount of nutrient recommended is needed (from soil test report) as well as the fertilizer analysis. For example, if the soil test recommends an application of 2.0 lb of N per 1000 square feet of garden and the fertilizer analysis is (15-10-5), an application of 13.3 lb per 1000 square feet of such a fertilizer is needed to supply the plant with its nitrogen needs ($2 \div 0.15 = 13.3$). In this example, P and K are also applied with this mixed fertilizer (15-10-5). If the soil test does not recommend additional P or K, applying "extra" P or K does not harm plant growth.

Although unlikely, water quality issues could be of concern if many gardens in a given area are overfertilized, especially with N and P.

For a straight nitrogen material such as 46-0-0, the amount to apply would be $2 \div 0.46 = 4.3$ pounds per 1000 square feet.

Organic fertilizers

This type of fertilizer generally contains organic matter and may include manures, composts, green cover crops, mulches, leaves, fish emulsions, blood meal, and many other organic materials. Organic matter is beneficial to the soil and when

incorporated, the decaying organic residue provides several benefits including:

1. Good soil structure, by binding individual soil particles together. This aggregation can help aeration and drainage, particularly in heavy clay soils.
2. Soil water, held by the organic matter, therefore lessening the need to water soils often. This is especially helpful for coarse sandy soils.
3. Plant nutrients, supplied through breakdown of the organic material by soil microorganisms.

Organic fertilizers are usually plentiful (compost and manures) and available to many gardeners for little cost. A disadvantage is that they usually need soil microbes to release the nutrients for plant use, and this can take some time. Applying the organic fertilizers in fall or early spring would be advisable.

Determining a rate of these materials to use to supply the needed plant nutrients can be difficult because of the variability of nutrients in these materials. An approximate rate of various materials to apply per 1000 square feet is given in tables 1 and 2. Another disadvantage of these materials is that they are a mixed fertilizer. In other words, if your soil test recommends only N and you apply an organic fertilizer, you will be applying other nutrients as well.

The variability of nutrients and the multiple nutrients contained in organic fertilizers can lead to applied nutrient levels that exceed your plant needs. This can be a problem if too much N is supplied to some vegetable crops. Water quality issues also could be of concern if many gardens in a given area are overfertilized, especially with regard to N and P.

For food-safety reasons, all manures should be at least 6 months old prior to application to vegetable production areas. Composting can reduce harmful bacteria, weed seeds, and salts in manures and is a recommended practice for many organic materials. To compost, mix a layer of approximately 6 to 8 inches of organic material with a 2-to 3-inch layer of soil. Keep the material moist but not wet. Stir the pile every 2 to 3 weeks.

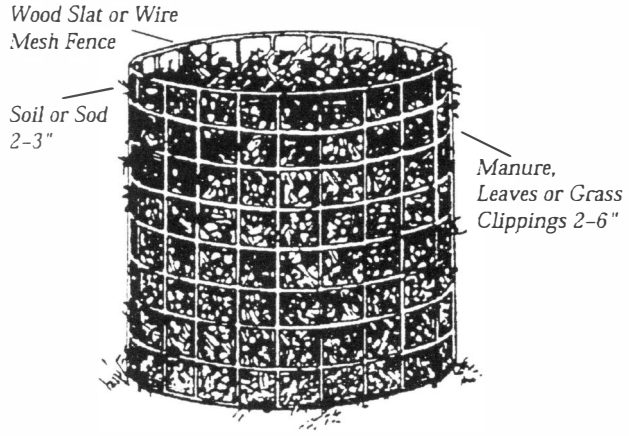


Table 1. Average N, P, and K contents of manures and amounts to provide 5.0 pounds of N per 1000 square feet.

Manure[1] *(assuming about 50% moisture)*	*N*	*P (as P2O5)*	*K (as K2O)*	*Amount to supply 5.0 lb N per 1000 ft² (30′ x 35′ area)*
	———	*%*	———	*pounds*[2]
Chicken	1.7	1.8	1.3	290
Sheep	1.3	0.9	1.9	380
Dairy	0.8	0.4	1.7	625
Cattle	0.8	0.6	1.1	625
Pig	0.6	0.5	0.6	830
Horse	0.4	0.3	0.7	1250

[1]Avoid applying fresh manure to growing plants. Instead, apply composted manure or apply and incorporate fresh manure the previous fall. Any manure applied to vegetable production areas should be at least 6 months old.
[2]If significant bedding is in the manure, these amounts should be doubled.

Table 2. Average N, P, and K contents of other organic fertilizer materials and amounts to provide 5.0 pounds of N per 1000 square feet.

Material	*N*	*P (as P_2O_5)*	*K (as K_2O)*	*Amount to supply 5.0 lb N per 1000 ft² (30′ x 35′ area)*
	———	*%*	———	*pounds*
Blood meal	13.0	0.9	0.5	38
Fish meal	10.0	6.0	0.0	50
Fish emulsion	4.0	1.5	1.5	125
Bone meal	3.0	22.0	0.2	165
Peat	2.0	0.3	0.6	250
Municipal compost (moist)	1.0	0.4	0.6	500
Cornstalks[1]	0.8	0.4	2.0	625
Leaves	0.7	0.3	0.6	715
Grass clippings (fresh)	0.6	0.3	0.8	835
Sawdust[1]	0.2	0.1	0.2	2500
Wood ashes[2]	0.0	1.5	3.5	—

[1]Cornstalks, sawdust, straw, and leaves should be composted before applying to garden.
[2]Wood ashes should not be applied if treated wood is burned. Wood ash tends to act as a liming material and should only be used on soils with pH below pH of 6.0 at a rate of 300 – 400 lb/1000 ft²

Quickly available vs. slowly available fertilizers

Most commercial fertilizers are very soluble (release nutrients quickly), and nutrients are immediately available for plant use. Some fertilizers release nutrients over a period of time (3–10 weeks) and are considered slowly available fertilizers. These less soluble fertilizers are more suitable for turf where a slow release keeps grass green for longer periods.

For most garden areas, an application of a quickly available fertilizer will work fine. For some very sandy soils, a slowly available fertilizer may reduce N leaching losses. Some of these slowly available materials include sulfur-coated urea or polymer-coated urea.

Many of the organic fertilizers (table 2) can be considered slowly available as well.

METHODS OF APPLICATION

Broadcast. Most fertilizers are spread over the soil surface and incorporated into the soil by tillage (plow, spade, rototiller, etc). Incorporation helps protect the nutrients from loss. In addition, it puts the nutrient close to the plant root for quick uptake.

The application should be uniform and can be done by hand or a small fertilizer spreader.

Band. The fertilizer is applied in a uniform band in the soil usually below and to the side of the plant seed or row. In general, this method has no particular benefit over broadcasting for most garden crops and can cause seed injury if applied too close to the seed.

Starter or transplant solution. Some young plants may respond to a weak solution of phosphorus applied after transplanting. These starter solutions can be purchased or made at home by mixing 2 tablespoons of a high-phosphorus fertilizer with 1 gallon of water. Dissolve as much as possible and apply about 1 cup of this solution around each plant.

Sidedressing. Fertilizer is applied to the side of the crop row sometime during the growing season. It can be beneficial to sidedress N for vine crops and tomatoes. Applying too much N at planting can produce heavy foliage and sometimes delay or retard fruit set. Split the recommended N into ⅓ broadcast before planting and the remainder as a sidedress just after most fruit has set for these crops. For very sandy soils, splitting the N application is done to limit the N washed out of the soil by rain or watering.

SOIL PH

A pH analysis measures the soil's acidity or alkalinity. The standard pH scale is from 0 to 14 with a neutral value at 7.0. Values below 7.0 are acid and above 7.0 are basic or alkaline. The range of pH for most soils in South Dakota is 6.0 to 8.0, although values lower and higher can be found.

Most plants grow very well within this pH range. However, some plants, such as blueberries, azaleas, and rhododendrons, prefer more acid conditions (4.0–5.5). Some berry crops, fruit trees, and beans may develop chlorotic symptoms (leaf yellowing with green veins) if the pH is above 7.3. In other instances, the soil pH may be so low (less than 5.6) that most plants would grow better with a more basic soil.

Lowering pH is not always easy. You can use elemental sulfur, but because this is a reaction that involves soil microbes, it can take up to 6 months for the soil pH to change.

If the soil has free lime (calcium carbonate), lowering pH is usually not practical, unless only a very small area (for a few plants) is treated. Free lime can be determined with a soil test—ask for it specifically. If free lime is not present, the amount of sulfur to use will depend on your current pH, your desired pH, and your soil texture. Ask your soil testing laboratory what amount of sulfur should be used to lower soil pH for your stated purpose, or use table 3 as a guide. In general, 20 to 30 pounds of finely ground sulfur is needed per 1,000 square feet of silt loam soil to lower the pH by one (1.0) unit if free lime is not present. The sulfur should be incorporated into the top 6-inches of soil. If you want to lower the pH of the top 12-inches of soil, the rate should be doubled and the sulfur worked into the top 12-inches.

Lowering soil pH in existing landscapes where incorporation is not possible will generally be unsuccessful.

Raising soil pH is somewhat more straightforward, in that there is a specific soil test used for making the recommendation. It is called the "lime need test." It will be run automatically by the SDSU Soil Testing Laboratory if the pH is 5.7 or below. If you request it, the test will be run for a charge up to a pH of 7.0.

Liming is really not necessary if your pH is 6.0 or above. For many soils, a recommendation of 90–100 lb of finely ground limestone per 1,000 square feet would raise soil pH from 0.5 to 1.0 unit. However, a lime need test should be used to make a specific lime recommendation (table 4). The limestone should be incorporated into the top 6-inches of soil.

Table 3. The amount of finely ground elemental sulfur to lower soil pH by one unit (1.0).

Texture	*Sulfur to apply*[1] *lb /1000 ft*
Coarse (sand, sandy loam, loamy sand)	10 – 20
Medium (loam, silt loam)	20 – 30
Fine (clay, silty clay loam, clay loam, peat)	30 – 40

[1] Assuming free lime is not present in the soil.

Many gardening references, catalogs, and garden retailers routinely recommend lime applications. Lime should not be applied unless its need is confirmed by a soil test.

Overapplying either sulfur or lime can have harmful effects. Too much sulfur can lead to high salt levels in the soil. Too much lime can cause some micronutrients to become unavailable for plant uptake. Therefore, a soil test is highly recommended before attempting to change your garden's pH.

Table 4. Raising soil pH with lime.

Lime test[1] (buffer test)	*Lime[2] required for 6-inch soil depth*
	lbs/1000 ft²
6.5 and greater	0
6.1 – 6.4	65
5.9 – 6.0	80
5.8 and lower	95

[1] Will automatically be run if soil pH is less than 5.6.
[2] Based on 100% calcium carbonate, very finely ground.

SOIL SALTS

Soil salts are naturally present in all soils. These soluble salts are minerals and nutrients that have dissolved from the soil and rock into soil water. If soluble salts become too high, they can be detrimental to plant growth. This usually occurs in soils where water tends to pond or concentrate, such as lower areas on the landscape or near saline seeps.

Salts can also accumulate in the garden if you are using irrigation water that is high in salts. Most municipal water sources have low salt concentrations, but some private wells may have higher-than-desirable salt levels. Waters can be checked for their irrigation suitability (total salts and sodium) by sending in a pint of water and asking for a garden irrigation suitability test. Send sample to:

Oscar E. Olson Biochemistry Labs
South Dakota State University
ASC 133, Box 2170
Brookings, SD 57007-1217
Tel 605-688-6172
Web: http://www.sdstate.edu/vs/obl/

A soil test will show the soil salt level and the interpretation. Typically, soils will have salt values less than 1.0 (mmho/cm). For most gardens, salt levels of less than 3.0 (mmho/cm) should not be a problem for plant growth, especially if the soil is kept moist. If your water supply has low salts and if the soil drains relatively well, you can lower the soil salt content by applying 6-to 8-inches of water as quickly as the soil can absorb it. That should move the salts below the root zones of many garden plants.

If the soil test indicates that the sodium portion of the soluble salts is high, soil structure and plant growth may be poor. The most common sources of added sodium are private wells (especially artesian water) and softened household water. Correction of this problem is very difficult, if not impossible. If growing plants is difficult and if the soil test indicates a sodium problem, move your garden to a different (low sodium) area.

Some useful measures

1 acre = 43,560 sq ft
1000 sq ft = 32 ft x 32 ft
100 lb/acre = approx 2 lb/1000 sq ft
3 tablespoons (level) = 1 ounce (liquids)
8 ounce = 1 cup (liquids)
2 cups = 1 pint (liquids)
1 pint (2 cups) = 1 pound of most dried fertilizers

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SOIL TEST REPORT

20000

Soil Testing Laboratory - Box 2207A - South Dakota State University - Brookings, SD 57007-1096 - ph. 605/688-4766 - fax 605/688-4667

Submitted by: Ima Gardener
12345 200th St
Anywhere SD 57000

Date Sampled: 7/27/2005
Date Received: 7/29/2005
Date Reported: 8/2/2005

INTERPRETATION OF SOIL TEST LEVELS

Alkaline		Satis-factory	SS			K	HIGH
			SS			K	
			SS			K	
			SS		P	K	
Satis-factory		Possible Problem	SS		P	K	MEDIUM
			SS		P	K	
			SS	OM	P	K	
	pH		SS	OM NO3	P	K	
Acid	pH	Poor	SS	OM	P	K	LOW
	pH		SS	OM NO3	P	K	
	pH		SS	OM NO3	P	K	
	pH		SS	OM NO3	P	K	

SOIL TEST RESULTS

Sample or Field ID	Texture Class	pH	Buffer pH	Soluble Salts mmho /cm	Sod-ium me/l	O.M. %	Nitrogen NO3-N lbs/A	P Olsen ppm	P Bray ppm	K ppm	Sulfur SO4-S lbs/A	Zn ppm	Fe ppm	Mn ppm	Cu ppm	Ca ppm	Mg ppm	Chlo-ride lbs/A	B ppm
Garden	**Medium**	**6.5**		**0.5**		**3.2**	**60**	**12**		**250**									
Depth 1: 0" - 6"							**60**												

RECOMMENDATIONS (lbs/1000 sq. ft)

		N	P2O5	K2O	S	Zn	Fe	Mn	Cu	Ca	Mg	Cl	B
1st choice	**Garden**	**1.7**	**0.8**	**0**									
2nd choice													

Recommendation(s) For 1st Crop Choice

1) For vegetable gardens, any P or K recommended should be broadcast on the surface and worked in during seedbed preparation. If recommended N is 1.5 lb/1000 sq. ft. or greater, split application with 1/3 applied during seedbed preparation and the remainder when vine crops, potatoes, and tomatoes have set fruit. If recommended N is less than 1.5 lb/1000 sq. ft., delay N application until vine crops have set fruit. For flower gardens apply recommended fertilizer in spring.

2) To supply the above nutrients, this formula is used to determine the quantity of a fertilizer you may have on hand: (pounds of element recommended / percent of that element in the fertilizer) x 100 = lbs. of fertilizer needed per 1000 sq. ft.
Repeat this calculation for each element that is recommended. Application of P2O5 or K2O in amounts greater than recommended will not be harmful to growth. Avoid broadcasting more nitrogen than recommended. However, a sidedressing of nitrogen after plants are growing may be advisable.

For additional information contact your County Extension Educator: County: Phone: