

APPENDIX A: How to Determine Your Soil Type using Web Soil Survey (WSS)

Web Soil Survey (WSS) provides soil data and information produced by the National Cooperative Soil Survey. It is operated by the USDA Natural Resources Conservation Service (NRCS) and provides access to the largest natural resource information system in the world. NRCS has soil maps and data available online for more than 95 percent of the nation's counties and anticipates having 100 percent in the near future. The site, located at <http://websoilsurvey.nrcs.usda.gov/app/> is updated and maintained online as the single authoritative source of soil survey information.

Requirements for Running Web Soil Survey

Supported Web Browsers

Web Soil Survey has been tested on the following browsers.

Microsoft Windows 7:

- Internet Explorer 9.0
- Firefox 16.0.1
- Google Chrome 22.0.1229.94

Microsoft Windows 7 - USDA CCE:

- Internet Explorer 8
- Google Chrome 22.0.1229.94

Microsoft Windows XP - USDA CCE:

- Internet Explorer 8
- Mozilla Firefox 16.0.1
- Google Chrome 22.0.1229.94

Apple Macintosh OS X:

- Safari 6

Screen Size

The optimal screen size for Web Soil Survey is 1024 × 768 pixels or higher. The software has been tested and works correctly at screen sizes as low as 800 × 600 pixels, but the smaller the screen, the more you will have to scroll.

Display Resolution

The optimal screen resolution for Web Soil Survey is 1024 × 768 or higher. The software has been tested and works correctly at resolutions as low as 800 × 600, but the lower the resolution, the more you will have to scroll.

JavaScript

To run Web Soil Survey, JavaScript is required. If JavaScript is disabled in your browser, the application simply will not work at all. You will see an error message in this case.

Cookies

Web Soil Survey maintains a session between the server and your browser. This requires that *session cookies* be enabled for the Web Soil Survey site. Session cookies are valid only for your current browser session. They are maintained only in browser memory, not written to your system's disk. If session cookies are not enabled, the application will end your session with a message saying session cookies must be enabled.

If you would like Web Soil Survey to remember your preferences after the end of the current session, you must enable *persistent cookies* for the Web Soil Survey site (nrcs.usda.gov). Persistent cookies are written to your system's disk, for use when you return to a web site in the future. Web Soil Survey does not require persistent cookies, except for this feature.

Popup Blocker




By default, Web Soil Survey opens some content in an external browser window, specifically:


- The Web Soil Survey home page
- Links to other sites
- PDFs created by **Printable Version** and "Get Now" in the **Shopping Cart** tab's **Checkout** form.

If you have a popup blocker configured, it will probably not allow this. If you wish to open these types of content in an external browser window, configure your popup blocker to allow popups from this site.

Alternatively, you can configure external content to open in the same browser window. Click the **Preferences** link in the navigation bar at the top of the page. Uncheck "Open Links and PDFs in External Windows" and press **Save Preferences**.

Instructions for using WSS:

1. Browse to the Web Soil Survey home page: <http://websoilsurvey.nrcs.usda.gov/app/>
2. Click on the green "Start WSS" button
3. Select address from the left navigation bar.
4. On the left side of the browser window, in the **Quick Navigation** panel, click on one of the selection methods. For example, open **Address**, type in the address of the desired location and click **View**.
5. Alternatively, open **State/County**, select your state and county, and click **View**.
6. Before you can view any soil data, you must define your Area of Interest (AOI). You can set your AOI by drawing a rectangle or a polygon on the map, or you can set your AOI to a whole Soil Survey Area. AOIs created using the AOI Rectangle and AOI Polygon tools are limited to a maximum of 100,000 acres, but Soil Survey Area AOIs are not.
7. After the map updates, click the *Zoom In* tool . Then click and drag a rectangle on the map to zoom to an area. Zoom in as close as you need to so you can see streets and landmarks you recognize.
8. After the map updates, click the *AOI Rectangle* tool . Click and drag a rectangle around the area of the map you wish to set as your Area of Interest. To stop in the middle of drawing an AOI and start over, when using the *AOI Rectangle* tool, press the **Esc** key *without releasing the mouse button*. To delete an AOI after drawing it, click the **Clear AOI** button in the **Area of Interest Properties** panel.
9. If the area you are interested in is not rectangular, you can use the *AOI Polygon* tool . Click points on the map to define your AOI. Double-click or CTRL-click the final point to finish. To start over when using the *AOI Polygon* tool, just press the **Esc** key.
10. The application will create the AOI you have specified. To delete an AOI after drawing it, click the **Clear AOI** button in the **Area of Interest Properties** panel.
11. To set your AOI to a whole Soil Survey Area, in Quick Navigation, open the Soil Survey Area form. Choose a state and Soil Survey Area using the dropdowns. Then click Set AOI.
12. Once you have set your AOI, click the Soil Map tab to see the soil map and map unit information.
13. To create a printable document containing the map and information on the Soil Map tab, click the Printable Version button, and then click the View button.

14. To run soil ratings or soil reports, click the Soil Data Explorer tab, then the one of the inner tabs: Suitabilities and Limitations for Use, Soil Properties and Qualities, or Soil Reports.
15. On the left side of the browser window, click the Open All button to expand all the folders, or click an individual folder to list the items within it.
16. Click one of the items to open the form, then set options as desired, and click View Rating or View Soil Report. This will show the data in tabular form and, for the Ratings, in color-coded map form. Click the Legend tab at the left side of the map to see a legend of the Rating values.
17. To create a printable version of the soil data, click Printable Version or Add to Shopping Cart:
18. Printable Version generates a PDF document containing the rating or report that you just ran.
19. Add to Shopping Cart adds the report or map to the shopping cart. You can add multiple ratings and reports to the shopping cart and then create a PDF document containing all the items you added to it. The AOI soil map and the list of map units and their descriptions are added to the shopping cart by default.
20. Once you're done adding content to the shopping cart, click the Shopping Cart (Free) tab, and then click the Check Out button. This will generate a single PDF containing all the items you added. By default, the Soil Map content is automatically included in your PDF.
21. For best results, limit the number of items you add to the shopping cart to ten or fewer.
22. Throughout Web Soil Survey, context-specific help is available by clicking the  Help buttons.

APPENDIX B: Calculating Fertilizer Rates

Conversion factors

To convert from	To	Multiply by
lb/A	lb/100 sq ft	0.0023
lb/A	kg/ha	1.12
kg/ha	lb/A	0.893
lb	oz	16
lb/A	lb/sq ft	0.000023
Strawberries		
lb/A	lb/100 ft of row	0.008
Raspberries and Blackberries		
lb/A	lb/100 ft of row	0.0184
lb/A	oz/plant	0.009
Blueberries		
lb/A	oz/plant	0.015
Currants and Gooseberries		
lb/A	oz/plant	0.012
lb/A	lb/100 ft of row	0.0184

Nitrogen sources and actual N calculations

To calculate the actual amount of fertilizer to apply, divide the desired amount of actual N (table below) by the percent N in the fertilizer and then multiply the result by 100. Apply the total amount of fertilizer in a 3-foot band in the row (1 foot band over the row for strawberries).

Nitrogen sources and calculation of actual N	
Fertilizer	% actual N in fertilizer
Ammonium nitrate	34.0
Ammonium sulfate	20.5
Calcium nitrate	15.0
Diammonium phosphate	17.0
Potassium nitrate	13.0
Urea	46.0

Example 1: How many pounds per acre of calcium nitrate should be applied on strawberries to give you an actual application rate of actual N 30 lbs/A?

Calculation:

$$\frac{30 \text{ lbs/A actual N}}{15 \text{ percent N in calcium nitrate}} \times 100 = 200 \text{ lbs/A calcium nitrate}$$

Example 2: The grower only has 500 feet of row – not an entire acre. How much calcium nitrate should be applied to provide a 200 lb/A rate of calcium nitrate?

$$0.008 \text{ lb/100 ft row} \times 200 \text{ lb/A} = 1.6 \text{ lbs/100 ft of strawberry row}$$

$$5 \times 1.6 = 8 \text{ lbs. of calcium nitrate for the entire 500 feet}$$

Example 3: How many pounds per acre of ammonium sulfate should be applied to a blueberry field to give an actual application rate of N 60 lb/A?

Calculation:

$$\frac{60 \text{ lbs/A actual N}}{20.5 \text{ percent N in ammonium sulfate}} \times 100 = \frac{293 \text{ lbs/A}}{\text{ammonium sulfate}}$$

Example 4: The grower will only be planting a 400 square foot area, not an entire acre. How much total sulfur will be required if the site has loamy soil and the current pH is 5.5?

Table 1 recommends 1000 lbs/A sulfur

$$1000 \text{ lbs/A} \times \begin{matrix} 0.0023 \\ \text{(see Appendix A)} \end{matrix} = 2.3 \text{ lb/100 sq. ft}$$

$$2.3 \times 4 = 9.2 \text{ lbs/400 sq. ft.}$$

Additional Resources

1. Hitchcock, R. and Kissel, D.E. *University of Georgia Fertilizer NPK Soil Fertilizer Calculator*
<http://aesl.ces.uga.edu/soil/fertcalc/>

APPENDIX C: Typical composition of some chemical sources of fertilizer nitrogen and potassium

Fertilizer	Percent by Weight of Fertilizer				
	N	P ₂ O ₅	K ₂ O	MgO	S
Ammonium sulfate	20.5	--	--	--	24.0
Anhydrous ammonia	82.0	--	--	--	--
Ammonium chloride	25.0-26.0	--	--	--	--
Ammonium nitrate	33.0-34.0	--	--	--	--
Ammonium nitrate-sulfur	30.0	--	--	--	5.0-6.0
Ammoniated ordinary super phosphate	4.0	16.0	--	0.5	10.0
Monoammonium phosphate	11.0	48.0-55.0	--	0.5	1.0-3.0
Diammonium phosphate	18.0-21.0	46.0-54.0	--	--	--
Ammonium phosphate-sulfate	13.0-16.0	20.0-39.0	--	--	3.0-14.0
Superphosphate (TSP)	46				
Calcium nitrate	15.0	--	--	--	--
Potassium nitrate	13.0	--	44	0.5	0.2
Sodium nitrate	16.0	--	--	--	--
Urea	45.0-46.0	--	--	--	--
Potassium chloride	--	--	60-62	--	--
Potassium sulfate	--	--	50-52	--	17
Potassium magnesium sulfate (Sul-Po-Mag)	--	--	22	11	22
Potassium nitrate	13	--	44	--	--
Potassium and sodium nitrate	15	--	14	--	--
Manure salts	--	--	22-27	--	--
Potassium hydroxide	--	--	83	--	--
Potassium carbonate	--	--	<68	--	--
Magnesium sulfate (Epsom salts)	10				

(Source: Bushway, L., Pritts, M., and Handley, D. 2008. Raspberry and Blackberry Production Guide.)

APPENDIX D: Micronutrient Sources

Nutrient	Product	Application Method*	Rate
Boron	Solubor (20% B)	Foliar	1.5 lb/A
		Ground	5.0 lb/A
	Borax	Ground	10.0 lb/A
Copper	Copper chelate	Foliar	Label rates
Iron	Iron Chelate	Foliar	Label rates
Manganese	Manganese chelate	Foliar	Label rates
	Manganese sulfate (32% Mn)	Foliar	2 lb/A
Zinc	Zinc chelate	Foliar	Label rates

(Source: Pritts, M. and Hancock, J. 1992. *Highbush Blueberry Production Guide*) *Apply foliar sprays when leaves are present; use 100-200 gal/A. Apply ground sprays at any time; use 20-50 gal/A. (Source: NRAES-55 *Highbush Blueberry Production Guide*)

APPENDIX E: Nutrient Content of Organic Materials Used for Macronutrient Supplementation

Fertilizer	Percent by Weight of Material ¹			
	N	P ₂ O ₅	K ₂ O	Release rate
Animal tankage (dry)	7	10	0.5	Medium
Bone meal (raw)	2-6	15-27	0	Slow
Bone meal (steamed)	0.7-4.0	18-34	0	Slow-Medium
Castor pomace	5	1.8	1	Slow
Coca shell meal	2.5	1.0	1	Slow
Compost (not fortified)	1.5-3.5	0.5-1.0	1.0-2.0	Slow
Cottonseed meal (dry)	6	2.5	1.7	Slow-Medium
Dried Blood (dry)	12	1.5	0.57	Medium-Rapid
Fertrell-Blue label	1-5	1	1-2	Slow
Fertrell-Gold label	2	1	2	Slow
Fertrell-Super	3	2	3	Slow
Fertrell-Super N	4	2	4	Slow
Fertrell-Super K	3	4	7	Slow
Fish meal (dry)	10	4	0	Slow
Fish meal (scrap)	3.5-12	1-12	0.80-1.6	Slow
Garbage tankage (dry)	2.7	3	1	Very slow
Guano (bat)	5.7	8.6	2	Medium
Guano (Peru)	12.5	11.2	2.4	Medium
Kelp ²	0.9	0.5	4-13	Slow
Manure ³ (fresh)				
Cattle	0.25	0.15	0.25	Medium
Horse	0.3	0.15	0.5	Medium
Sheep	0.6	0.33	0.75	Medium
Swine	0.3	0.3	0.3	Medium
Poultry 75% water	1.5	1.0	0.5	Medium-Rapid
Poultry 50% water	2	2	1.0	Medium-Rapid
Poultry 30% water	3	2.5	1.5	Medium-Rapid
Poultry 15% water	6	4	3	Medium-Rapid
Marl	0	2	4.5	Very slow
Milorganite (dry)	5	2-5	2	Medium
Mushroom compost	0.4-0.7	0.6	0.5-1.5	Slow
Peat and Muck	1.5-3.0	0.25-0.50	1.0	Very slow
Sawdust	4	0.2	0.4	Very slow

Sewage sludge (activated, dry)	2-6	307	0-1	Medium
Sewage sludge (digested)	1-3	0.5-4	0-0.5	Slow
Tanbark ⁴	0	1.5	2	Very slow
Tobacco stems (dry)	2	0.7	6.0	Slow
Urea ⁵	42-46	0	0	Rapid
Wood ashes ⁶	0	1-2	3-7	Rapid

(Original source: Pennsylvania State University "Organic Gardening Culture and Soil Management"; updated for this publication 4/14)

¹ The percent of plant nutrients is highly variable, and with some materials, mean percentages are listed.

² Contains common salt, sodium carbonates, sodium and potassium sulfates.

³ Plant Nutrients available during year of application.

⁴ Contains Calcium.

⁵ Urea is an organic compound, but some organic growers/certifiers consider it unacceptable because it is synthetically produced.

⁶ Potash content depends on the tree species burned. Wood ashes are alkaline, containing approximately 32% CaO and may have an effect on pH.

APPENDIX F: Cover Crops for Blueberry Plantings *(Dr. Marvin Pritts, Cornell University)*

The blueberry grower can use cover crops in several ways that will improve the health and productivity of a blueberry planting. Cover crops can be used before the blueberries are planted, plants can be set into a killed cover crop, and cover crops can be seeded between the rows of established plantings. In all three cases, cover crops help to improve soil structure and organic matter content, and suppress weeds and possibly nematodes.

Preplant Cover Crops

Seeding a cover crop on a proposed planting site a year or two before planting is an excellent way to improve soil structure, especially on sandy soils where organic matter content may be low. Cover crops will prevent erosion on sloped sites prior to planting blueberries. Most cover crops grow under a wide range of soil conditions, and except for small additions of N, P and K (typically 40 lbs/A of each), other amendments are not likely to be required. Although the optimal pH for most cover crops is 6 - 7, most grasses will grow satisfactorily at a soil pH of 4.5 or higher.

Minimum seeding rates are used when the objective is to supply an acceptable stand for harvesting the grain or straw. But when a vigorous, dense stand is desired for weed suppression and organic matter, higher seeding rates are used. Small grains or seed from clover or buckwheat cover crops can be harvested and sold to recoup establishment costs.

Preplant cover crops are usually plowed under in the late fall or early spring prior to planting. Those with low nitrogen contents (grains and grasses) should be plowed under in fall to allow adequate time for decomposition. Legumes contain more nitrogen and decompose quickly, so can be turned down within a month of planting. However, the pH of a blueberry site is likely to be too low for good growth of a legume (e.g. alfalfa, clovers and vetches).

Preplant covers as killed sods

Some growers are experimenting with planting berry crops into a mowed or killed sod of grain rye, rather than planting into bare soil. This method reduces the requirement for herbicides in the first year - at a time when many plants are sensitive to even low rates.

A sod residue suppresses weeds for several weeks while the blueberry row becomes established, and minimal soil disturbance results in reduced weed seed germination. To use this system, seed grain rye in autumn, and mow it in spring when the rye plants start to flower (or spray it with an herbicide). Wait a couple of days then plant into the rye residue. Apply mulch down the rows of plants. With this system, creating bare soil suitable for weed growth is minimized. Weeds are controlled for 6 to 8 weeks after planting without any herbicide, and for even longer when followed by a preemergent herbicide and a mulch.

Alleyways

Many blueberry growers find it advantageous to establish a permanent sod cover in the alleyways of blueberry plantings. A sod alley allows pickers to enter the field shortly after a rain and prevents injury to the root system of the blueberry plant that occurs when row middles are cultivated. Alleyways must be mowed, and occasionally fertilized, but otherwise require little maintenance.

Perennial grasses (i.e. ryegrass and fescues) are the best choices for row middles. They establish well, do not grow tall, and do not spread laterally at a fast rate. However, they are sufficiently competitive with other plants to reduce weed numbers in the planting. Seed permanent cover crops in September, if possible, when temperatures are cooler and rainfall is more dependable. If grasses are seeded in late spring, overhead irrigation may be required to promote germination. Some growers seed the entire area with grass the autumn prior to planting blueberries and then spray out strips with glyphosate prior to planting. Others plant the blueberries first then seed the grass in September of the first growing season.

Selecting a cover crop

The selection of a cover crop should depend upon several conditions: 1) time of year when a cover crop is desired, 2) the crop to follow, 3) pH and soil fertility, 4) available tillage equipment, and 5) the length of time the crop will be allowed to grow. The following are descriptions of a few cover crops suitable for use in low pH soils. The relative characteristics of cover crops for low pH soils are discussed.

Preplant only

Buckwheat. This crop is a useful preplant cover on a site with a low soil pH. While the top portion of the plant grows quickly, there is little organic matter contribution from the roots. Reseeding will occur readily if plants are allowed to go to seed, so incorporate shortly after flowering. Earlier seedings in late May or early June are superior to summer seedings in late July.

Annual Field Brome. This is a fast establishing winter annual grass that has a much more extensive and fibrous root system than most other green manure crops. Seedings made during July and August tend to be much more successful than seedings made in late the spring. The following year's spring growth is rapid and after the seed ripens in July, the crop will die. If the soil is disked when the seeds start to fall, then the crop can be reestablished easily with no further seeding. Plan to thoroughly disk or plow down this heavy root system early in the spring. This seed is not readily available so plans for obtaining it should be made well in advance of the normal seeding date. Annual field brome is usually seeded at a rate of 20 pounds per acre.

Japanese Millet. This is a fast growing summer annual which will compete well with weeds and will establish faster on cooler soils than sudangrass. Planted from late May to mid-July, this plant will achieve a height of four feet in seven or eight weeks. Unlike small seeded legumes and grasses, the seed of millet should be covered from 3/10 to 1 inch deep in a firm seedbed. The planting may be cut back and allowed to regrow at any time after twenty inches of growth is obtained. Millet should not be allowed to mature and drop seed. The seed of millet is relatively inexpensive; at a seeding rate of 20 pounds per acre the cost of seed is approximately \$7.00.

Spring Oats. When used as a very early spring green manure crop, oats should be planted in early to mid-April. Because of oats fast spring growth, plan to incorporate them into soil in early to mid-June. Oats will grow on soils of relatively low soil pH (5.5) and with moderately good fertility; however, this crop requires good soil drainage. A mid-August seeding will provide good growth and ground cover for protection against soil erosion during the fall and winter months. Oats will be gradually killed back by successive frosts and will not grow again in the spring. The dead plant residue is easily incorporated with very light tillage equipment. Three bushels of oats are usually planted (approximately 100 pounds) at a seed cost of \$17.00 per acre.

Annual Ryegrass. Seedings establish very rapidly in spring or late summer. Ideal dates for spring seedings range from early April to early June and late summer seedings are more successful when made from early August to early September. The heavy root growth and the rapid seeding development make annual ryegrass a very desirable green manure cover crop in areas where good soil-water relations can be maintained. The ryegrass will die out early in the second year leaving a heavy root system and a moderate top growth residue to incorporate into the soil. A seeding rate of 30 pounds per acre is suggested, at an approximate cost of \$15.00.

Sudangrass. This is a summer annual that requires heat for good growth. Seedings made in late May or early June will guarantee a more vigorous growth than seedings made in late June or early July. Hybrid sudangrasses may have larger seeds and should be planted at heavy rates. Like millet and sorghum-sudan hybrids which have large seeds, sudangrass should be seeded to a depth of one half to one inch into a firm seedbed. Similarly, this summer annual will recover following removal of the top. Due to the tall habit, the crop should be cut back when growth exceeds 20-25 inches or plowed down if a second growth is not desired.

Sorghum-sudangrass hybrids. This summer annual requires more heat for growth than sudangrass. It is more expensive to establish and fails to adapt to most soils as readily as Japanese millet. This crop will grow to a greater size than sudangrass under ideal conditions of heat, moisture, and fertility, but the 4-6 foot growth is

very difficult to incorporate with small or moderate sized tillage equipment. Like sudangrass, this crop will make a second growth if climatic conditions will permit. Growth will cease by mid-September in years when night temperatures drop to near freezing. The seeding rate will vary from 35-50 pounds depending upon the size of the seed; therefore, the cost of seed can range from \$20.00-30.00 per acre.

Marigolds. Marigold is a relatively new cover crop that has generated much interest among berry growers for its ability to suppress weed and nematodes. Marigolds are commonly used as a preplant cover crop in Northern Europe. As a warm season crop, marigolds germinate only when soil temperatures exceed 65F. Seed at the rate of 5 lb/A and shallowly incorporate the seed. Overhead irrigate to promote germination. Plants do not have to flower to provide benefits.

Use open-pollinated seed rather than the expensive hybrid seed. Open-pollinated seed sells for about \$30/lb. Little is known about suitability of various varieties of marigold as a preplant cover crop.

Winter Rye. This cereal grain establishes fast from late summer and early fall seedings, even on low pH soils. Fall seedings made after October 1 are likely to provide only winter cover and are slower to produce heavy spring growth. Excessive early spring top growth can create tillage problems if the crop is not incorporated by early to mid-May. This date will vary with the location and season. The seed is readily available at a cost of \$20.00 for the 100 pound seeding rate. Seed is often sold in bushel quantities of 56 pounds.

Permanent row middles

Fescues. Several types of fescues are available for permanent row middles such as creeping red, Chewings, hard and tall. Each are seeded at a rate of 70 - 80 lbs/A in April-May or August-September, and costs about \$3.00/lb. Tall fescue is most tolerant of the four to low pH soils. Often these are sold as mixtures with other species because most fescues are slow to establish. These companion mixes consist of species that germinate and establish quickly, but are less competitive so will later be replaced by them. Creeping, Chewings and hard fescues require little mowing.

Perennial Ryegrass. Seedings of perennial ryegrass become established faster than seedings of other common perennial grasses such as the fescues, timothy, brome grass and orchardgrass. Perennial ryegrass can be used as a preplant cover crop because the fibrous root system and vigorous top growth provide substantial material for incorporating into the soil in early spring. Also, perennial ryegrass can be used as a permanent grass for between the rows, and some varieties require little mowing. The dry matter root growth is approximately equal to the top growth. With many crops, the top growth represents sixty to seventy percent of the material turned under at plowing. A 25 pound seeding rate results in a seed cost of approximately \$30.00 per acre.

Table 31. *Relevant characteristics of various cover crops for low pH soils.*

Cover crop ¹	Water use	Establishment	Vigor	Durability
Hard fescue	Mod ²	F	Lo	Ex
Tall fescue	MHi	G	Hi	Ex
Creeping red fescue	Mod	VG	Lo	VG
Chewings fescue	Mod	G	Lo	VG
Perennial ryegrass	Mod	G	Mod	G
Annual ryegrass	Mod	G	Mod	P
Rye (<i>Secale cereale</i>)	Hi	VG	Hi	P
Buckwheat	Hi	VG	Hi	P
Sudan grass & hybrids	Hi	VG	Vhi	P
Oats	Hi	VG	Hi	P
Marigold	Hi	F	Mod	P

¹Mixtures of sod grass types may perform better than single species.

²Key to ratings: P=poor, F=fair, G=good, VG=very good, Mod=moderate, MHi=mod high, Ex=excellent, Hi=high, Lo=low.