

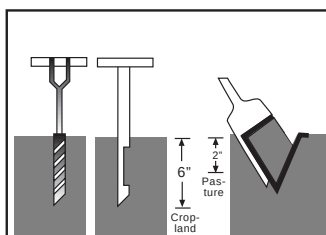
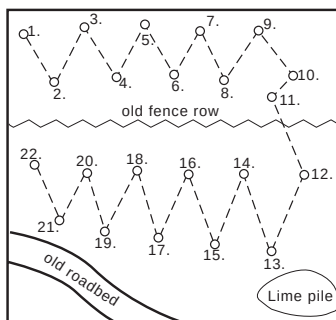
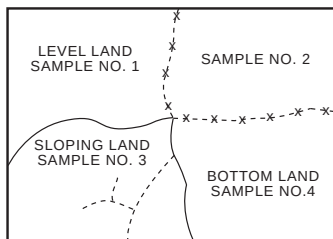
PART VII

Soil Testing and Plant Analysis

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Soil testing and plant analysis are important agronomic tools for determining crop nutrient needs. Soil testing evaluates the fertility of the soil to determine the basic amounts of fertilizer and lime to apply. Plant analysis, on the other hand, is used as a monitoring tool to determine if the fertilization and liming program, as determined by the soil test, is providing the nutrients at the necessary levels for top yields. Plant analysis is the ultimate test; i.e., is the plant obtaining from the soil ample nutrients for good growth and development. If not, nutrients can be added during the existing growing season to improve yields, or the fertilization program can be modified for next year's crop. The following sections discuss how to use soil testing and plant analysis to evaluate crop nutrient needs.

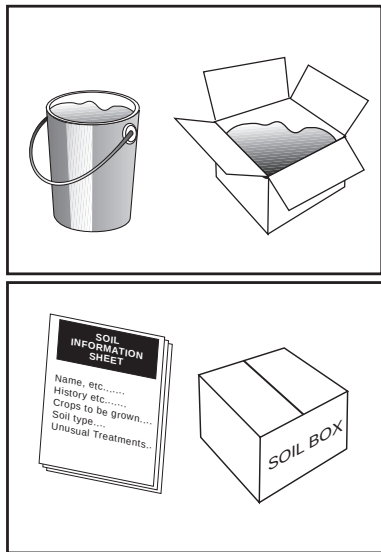
Soil testing



Sampling Instructions – Collecting the sample is one of the most important steps in the soil testing program. When one considers that a 2-lb soil sample must adequately represent 10 million or more lbs of soil in the area being sampled, the importance of doing a good job of sampling becomes apparent. Here are instructions for collecting a good representative soil sample:

Sampling soil

1. Get **Soil Sample** Information Sheets and Soil Boxes. These may be obtained from your local Extension office or from the Virginia Tech Soil Testing Lab. Follow the directions they provide.
2. **Divide Farm** into Areas or Fields. If the field is uniform, one sample will do. But most fields will have been treated differently, or the slope, drainage, or soil type will make it desirable to divide the field into small areas of 5 to 10 acres each.
3. Obtain a **Good Sample** of Soil. The soil test can be no better than the sample. Take the sample from 20 or more places in the field. Zig-zag across the field or area as shown in the diagram. When taking the sample, avoid unusual places such as old fence rows, old roadbeds, eroded spots, where lime or manure have been piled, or in the fertilizer band of row crops.
4. Use Proper **Sampling Tools**. Sampling may be made with a soil auger, soil tube, or spade. The desired depth for cropland is plow depth (6 to 8" or more), and 2-4" for pasture land, or no-till crop fields. Place sample in clean container.



5. **Mix Well in Clean Plastic Pail.** From the 20 or more stops you have made, you now have one gallon or more of soil. Mix it thoroughly, then send about 1/2 pint of the mixed soil to the lab for analysis.
6. **Fill Out** a Soil Sample Information Sheet for Each Sample. It is essential that your name, address, and sample number be plainly written on the sheet you send with each sample. As a guide in making recommendations for each of your numbered areas, it is important that the history of fertilization, liming and any unusual treatments be stated.
7. **Mail** to Soil Testing Laboratory. Place the Soil Sample Information Sheet inside the top flap of the soil box and mail to the Soil Testing Laboratory, Department of Crop & Soil Environmental Sciences (0465), Virginia Tech, Blacksburg, VA 24061.

Soil sampling for precision farming

Precision farming, also known as **site-specific management**, typically employs intensive soil sampling to map fertility in a field. Fertilizer and lime may then be applied at variable rates, according to the needs of the particular areas in the field. To begin, fields are first divided into grids, with typical grid size being 2.5 acres. For small fields, a one acre grid size will give a more precise representation of the fertility across the field, but for larger fields, this is usually not economically feasible. The grid is established using the Global Positioning Satellite (GPS) system. A radio receiver, connected to a portable computer, and mounted on an ATV, is used to receive satellite coordinate signals to map the field and locate the grid points. Soil samples are then collected at each grid point, with 6-8 subsamples being taken in a 10' circle around the ATV, and mixed together for a composite sample. After lab analysis, soil test information from the field can then be fed into a computer mounted in a variable-rate fertilizer/lime spreader with GPS receiver, and material can then be applied according to the needs of the various areas in the field.

“**Smart sampling**” techniques may also be employed to sample a field. This may be done in lieu of the above standard (uniform) grid sampling or as a followup to an initial grid sampling of the entire field. “Smart sampling” consists of sampling those areas of the field that are obviously different, such as with respect to topography (hilltops, low areas), or if a combine yield monitor has been used, high-yielding and low-yielding areas in the field. If yield data are not available, one often times has a good idea of the high-yielding and low-yielding areas in his field. These should be sampled separately. If the field has been mapped, it can be divided by soil series (i.e., soil mapping unit). Grid points should be located or grouped in those areas with unique visible or measurable differences.

Using the Soil Test Report – The Soil Test Report will contain the laboratory test results plus fertilizer and lime recommendations. Additional information regarding time and method of fertilizer and lime application will also be provided in the form of a Soil Test Note or Notes which will accompany the report. When several samples have been collected from the same field, the soil test reports should be compared to determine the best rates of fertilizer and lime to use for the field. Large differences in the reports may call for fertilizer and/or lime at two or more different rates. Advice on how to best fertilize a given field can be obtained from your local Extension agent or fertilizer dealer.

Plant Analysis

Sampling Instructions

1. **Avoid** submitting sample tissue that is contaminated with dust or soil. If tissue is dusty or dirty, remove as much of it as you can by shaking, brushing, or washing the tissue in gently-flowing water.
2. **Do not** sample disease, insect, or mechanically damaged plant tissue.
3. **Place** the plant tissue in a clean paper bag. Do *not* use plastic bags. If the sample is wet or succulent, let it air-dry in the open for one day before sending it to the laboratory. Identify each sample by number and crop name.
4. **When using** tissue analysis in the diagnosis of crop production problems, take one sample from the *problem* area in the field and one from an area where plants appear *normal*.
5. **When sampling**, both the *time* (growth stage) and *plant part* collected are important. Be sure to sample at the recommended time and collect the proper plant part.
6. **If you do not have** specific sampling instructions for the crop you wish to have analyzed, a good rule of thumb is to sample mature leaves that are representative of the current season's growth during the mid period of the growth cycle or just prior to seed set.
7. **Submit samples** to recommended labs for testing. **Virginia Tech does not run tissue analysis.**

Interpreting the Laboratory Results – The Plant Analysis Report will contain the tissue test results plus the optimum nutrient ranges for the crop sample. Note whether levels are deficient, borderline, or adequate for good crop growth. Also, make comparisons in soil nutrient levels between problem versus normal areas, noting any differences and whether they are small or large. Depending on what nutrient or nutrients are deficient and the stage of growth of the crop, it may or may not be worthwhile making additional fertilizer applications for the present crop. If trace element deficiency is noted and it is early enough in the growing season, a foliar application of the trace element can be applied to correct the problem. Following harvest, a more lasting soil application can be made for the next crop in the rotation. If low magnesium and phosphorus plant tissue levels are observed and the corresponding Soil Test Report indicates that the pH is low, it may not be possible to correct the problem for the present crop. Lime needs to be in the root zone to correct the problem and this can be a difficult thing to do if it is not possible to till the lime into the soil. However, remedial action can and should be taken to ensure that the problem does not arise in future crops. The actual treatment needed will depend on the nature and severity of the problem and the economics involved. In most cases, it is usually worth the cost and effort to correct the problem.

Table 1. Sampling Instructions for Field Crops

Crop	Time	Plant Part to Sample	No. of Plants to Sample
Alfalfa	Early bloom	Top 4-6" of plant	30
Bermudagrass	Optimum time for maximum quality hay	Upper half of plant	50
Corn	Prior to 4th leaf stage	Whole plant, cutting at ground level	30
	Prior to tasseling	Entire leaf immediately below whorl, removing at stalk	20
	At silk when silks are still green	Entire ear leaf, removing at stalk	20
Cotton	At full bloom	Youngest recently mature leaves on main stem, collecting 2 leaves per plant	25
Peanut	At bloom stage	Last fully mature leaves at top of the plant, collecting 3 leaves per plant	25
Small Grains	Prior to jointing	Whole plant above ground, remove dead leaves	50
	Jointing to heading	Uppermost fully developed leaf	50
Soybeans	Prior to or at initial bloom	Uppermost fully developed trifoliate leaf set (composed of 3 leaflets) per plant. Remove leaf stem (petiole)	25
Tobacco	Prior to or at bloom	Entire 4th leaf from the top of the plant	15

Table 2. Sampling Instructions for Fruit, Nut,

Crop	Time	Plant Part to Sample	No. of Plants to Sample
Fruit, nut			
Apple	8 to 10 weeks after full bloom	Leaves from spurs or near base of current season's growth, taking 4 to 8 leaves per tree	25 trees
Blueberry	Mid-summer	Mature leaves from mid-portion of current season's growth, taking 4 to 8 leaves per bush	25 bushes
Cherry	Mid-summer	Mature leaves near base of current season's terminal growth, taking 4 to 8 leaves per tree	25 trees
Grape	4 to 8 weeks after peak bloom	Petioles only (discard leaves) from mature leaves or nodes just beyond fruiting clusters	50 petioles
Peach	12 to 14 weeks after bloom	Mature leaves from mid-portion or near base of current season's terminal growth, taking 4 to 8 leaves per tree	25 trees
Pear	Mid-summer	Mature leaves from spurs, taking 4 to 8 leaves per tree	25 trees
Pecan	July 7 to August 7	Middle pair of leaflets from middle leaf of terminals around periphery of tree	25 trees
Vegetable			
Asparagus	Midgrowth	Mature fern from 18-36" up	10
Beet	Midgrowth	Young mature leaf, 3 leaves/plant	25
Broccoli	Heading	Young mature leaf, 2 leaves/plant	
Brussels sprout	Midgrowth	Young mature leaf, 3 leaves/plant	25
Cabbage	Head half grown	Young wrapper leaf, 2 leaves/plant	30
Cantaloupe	Prior to or at initial fruit set	Mature leaf near growing tip, 3 leaves/plant	25
Cauliflower	Buttoning	Mature leaf with stem removed	30
Collards	Midgrowth	Young mature leaf, 3 leaves/plant	25
Cucumber	Prior to or at initial fruit set	Mature leaf near growing tip, 3 leaves/plant	25
Green beans	Prior to or at early bloom	Uppermost mature leaves, 3 leaves/plant	20
Kale	Midgrowth	Young mature leaf, 3 leaves/plant	30
Onion	Midgrowth	Young mature leaf, 2 leaves/plant	30
Peas	Bud to full bloom	Entire top growth	15
Peppers, bell	Midgrowth	Young mature leaf, 3 leaves/plant	30
Potatoes, Irish	Tubers half grown	Young mature leaf, 3 leaves/plant	25
Spinach	Midgrowth	Young mature leaf, 2 leaves/plant	25
Sweet corn	At silking when silks are green	Entire ear leaf, removing at stalk	20
Sweet potato	Midgrowth	4 th leaf from a primary vine, counting down from growing tip	30
Tomato,	Early fruiting	3 rd and 4 th leaf from growing tip mech. harvest	50
Turnip greens	Midseason	Young mature leaf, 3 leaves/plant	25
Watermelon	Prior to or at initial fruit set	Mature leaf near growing tip, 3 leaves/plant	25
Turf			
Kentucky bluegrass	Normal growing season mowing	Clippings 7 to 14 days after last	1 pint

Table 3. Plant Nutrient Sufficiency Ranges for Field, Forage, Fruit, and Nut Crops*

Crop**	N	P	K	Ca	Mg	Mn	ppm				
							Fe	B	Cu	Zn	Mo
Field, Forage											
Alfalfa	4.50-5.00	0.35	2.20	0.80	0.40	25	30	15	7	15	0.5
Bermudagrass	2.00-3.00	0.20-0.50	1.50-2.50	0.25-0.75	0.15-0.50	50-250	50-300	5-20	6-20	20-50	-
Corn-up to 12" tall	3.50-5.00	0.30-0.50	3.00-4.00	0.30-0.70	0.20-0.60	30-300	50-250	4-25	3-20	20-60	0.2
Corn-ear leaf at silk or leaf below whorl	3.00-3.50	0.25-0.45	2.00-2.75	0.25-0.80	0.20-0.50	30-200	50-300	3-20	3-20	20-60	0.2
Cotton	3.50-4.50	0.30-0.50	2.00-3.00	2.25-3.00	0.50-0.90	50-350	50-250	20-60	8-20	20-60	—
Peanut	3.50-4.50	0.25-0.50	2.00-3.00	1.25-2.00	0.30-0.80	50-350	50-300	25-60	-	20-50	0.5
Small grains	4.00-5.00	0.20-0.40	1.50-3.00	0.20-0.50	0.15-0.50	25-100	25-100	3-20	5-25	20-70	—
Soybeans	4.25-5.00	0.30-0.50	1.75-2.50	0.50-1.50	0.25-0.80	20-200	50-300	25-60	6-30	20-50	0.5
Tobacco	3.50-4.25	0.25-0.50	2.50-3.20	1.50-3.50	0.20-0.65	30-250	50-200	20-50	15-60	20-80	—
Fruit, Nut											
Apple	2.00-3.00	0.15-0.50	1.25-3.00	1.00-2.00	0.20-0.50	20-200	50-400	20-60	5-20	15-50	—
Blueberry	1.80-2.00	0.10-0.20	0.40-0.60	0.30-0.75	0.20-0.30	20-200	60-150	10-50	10-20	10-50	—
Cherry	2.00-3.00	0.15-0.50	1.25-2.50	1.50-2.50	0.20-0.50	20-200	50-400	20-60	5-20	15-50	—
Grape	0.80-1.00	0.20-0.50	1.50-2.50	1.75	0.40-0.80	30-200	30	40-60	5-20	20-50	—
Peach	2.75-3.50	0.25-0.50	1.20-2.50	1.50-2.50	0.20-0.50	20-200	60-400	20-100	5-20	15-50	—
Pear	2.20-3.00	0.15-0.50	1.00-3.00	1.00-2.00	0.20-0.50	20-200	50-400	20-60	5-20	15-50	—
Pecan	2.50-3.90	0.12-0.30	1.00-1.50	0.70-1.50	0.30-0.60	100-800	50-300	20-45	10-30	50-100	—

*In general, if leaf composition is less than the lower value, yields may be reduced and deficiency symptoms may be visible. When leaf composition values are greater than the upper value, in some cases yields may be reduced and toxicity symptoms may be visible. **It should be noted that** temperature, moisture, and other factors also influence plant nutrient levels and sometimes make the interpretation of results difficult. Where possible, tissue analysis results should be compared between problem and normal growth areas and also compared with soil test results before a diagnosis is made. Information on crop management (planting time, depth, etc.) should also be included in the diagnosis.

****Sufficiency ranges are only applicable to the plant part and time of sampling specified in Tables 1 and 2. These values do not apply to other plant parts or times of sampling.**

Table 4. Common Plant Nutrient Ranges Found in Vegetable Crops and Turf

Crop* Vegetable	N	P	%K		Ca	Mg	Mn	ppm			
								Fe	B	Cu	Zn
Asparagus	2.4-3.8	0.30-0.35	1.5-2.4		0.40-0.50	0.15-0.20	10-160	-	50-100	-	20-60
Beet	3.5-5.0	0.20-0.30	2.0-4.0		2.5-3.5	0.30-0.80	70-200	-	60-80	-	15-30
Broccoli	3.2-5.5	0.30-0.70	2.0-4.0		1.2-2.5	0.23-0.40	25-150	100-300	30-100	1-5	45-95
Brussels sprout	2.2-4.2	0.26-0.45	2.4-3.4		0.3-2.2	0.23-0.40	-	-	30-40	-	-
Cabbage	3.0-4.0	0.30-0.50	3.0-4.0		1.5-3.5	0.25-0.45	-	30-60	30-60	-	20-30
Cantaloupe	2.0-3.0	0.25-0.40	1.8-2.5		5.0-7.0	1.0-1.5	-	-	30-80	-	30-50
Cauliflower	3.0-4.5	0.54-0.72	3.0-3.7		0.72-0.79	0.24-0.26	-	-	-	-	43-59
Collards	4.0-5.0	0.30-0.60	3.0-4.0		3.0-4.0	-	-	-	50-80	-	-
Cucumber	-	-	-		-	-	-	-	50-80	-	20-40
Green beans	3.0-6.0	0.25-0.50	1.8-2.5		0.8-3.0	0.25-0.70	30-300	300-450	40-60	15-30	30-60
Kale	4.0-5.0	0.30-0.60	3.0-4.0		3.0-4.0	-	-	-	50-80	-	-
Onion	1.5-2.5	0.25-0.40	-		-	-	-	-	30-45	-	10-15
Peas	3.1-3.6	0.30-0.35	2.2-2.8		1.2-1.5	0.27-0.35	-	-	20-60	-	-
Peppers, bell	3.0-4.5	0.30-0.70	4.0-5.4		0.4-0.6	1.0-1.7	-	-	40-100	10-20	-
Potatoes, Irish	3.0-5.0	0.20-0.40	4.0-8.0		2.0-4.0	0.5-0.8	30-50	70-150	30-40	-	20-40
Spinach	4.0-6.0	0.30-0.50	3.0-4.0		0.6-1.0	1.6-1.8	30-60	220-245	40-60	5-7	50-75
Sweet corn-ear leaf at silk	2.6-3.5	0.20-0.30	1.8-2.5		0.15-0.30	0.20-0.30	-	-	20-30	-	-
Sweet potato	3.2-4.2	0.20-0.30	2.9-4.3		0.75-0.95	0.40-0.80	40-100	-	-	-	-
Tomato, mech. harvest	3.0-6.0	0.50-0.80	2.5-4.0		0.6-0.9	60-100	-	40-80	4-8	15-30	-
Turnip greens	3.5-4.5	0.35-0.60	-		3.0-5.0	-	60-80	-	30-60	-	-
Watermelon	2.0-3.0	0.20-0.30	2.5-3.5		2.5-3.5	0.6-0.8	-	-	-	4-8	-
Turf											
KY bluegrass	2.2-3.8	0.30-0.55	1.8-3.0		0.75-1.35	0.25-0.50	150-400	100-200	10-30	10-20	35-45

*Nutrient ranges apply only to the plant part and time of sampling specified in Table 2. These values do not apply to other plant parts or times of sampling.

Nutrient Removal By Crops

Crop	Plant part	Acre yield	N	P as P ₂ O ₅	K as K ₂ O	Ca	Mg	S	Cu	Mn	Zn
lbs											
Row Crops											
Barley	grain	80 bu	70	30	20	2	4	6	0.06	0.06	0.12
Barley	straw	2 ton	30	10	60	16	4	8	0.02	0.64	0.10
	Total		100	40	80	18	8	14	0.08	0.70	0.22
Corn	grain	150 bu	135	53	40	2	8	10	0.06	0.09	0.15
Corn	stover	4.5 tons	100	37	145	26	20	14	0.05	1.50	0.30
	Total		235	90	185	28	28	24	0.11	1.59	0.45
Cotton	seed and lint	1500 lbs	40	20	15	2	4	3	0.06	0.11	0.32
Cotton	stalks, leaves	2000 lbs	35	10	35	28	8	15	-	-	-
	Total		75	30	50	30	12	18			
Oats	grain	80 bu	50	20	15	2	3	5	0.03	0.12	0.05
Oats	straw	2 tons	25	15	80	8	8	9	0.03	-	0.29
	Total		75	35	95	10	11	14	0.06	-	0.34
Peanuts	nuts	1.25 tons	90	10	15	1	3	6	0.02	0.01	-
Peanuts	vines	4500 lbs	105	25	95	-	-	-	-	-	-
	Total		195	35	110						
Sorghum	grain	60 bu	50	25	15	4	5	5	0.01	0.04	0.04
Sorghum	stover	3 tons	65	20	95	29	18	-	-	-	-
	Total		115	45	110	33	23	-	-	-	-
Soybeans	grain	40 bu	150	35	57	7	7	4	0.04	0.05	0.04
Soybeans	straw		30	10	25	-	-	-	-	-	-
	Total		180	45	80						
Tobacco	leaves	2000 lbs	75	15	120	75	18	14	0.03	0.55	0.07
Tobacco	stalks		35	15	50	-	-	-	-	-	-
	Total		110	30	170						
Wheat	grain	80 bu	100	45	49	2	16	8	0.06	0.18	0.28
Wheat	straw	2.0 tons	34	9	113	12	8	12	0.02	0.32	0.10
	Total		134	54	162	14	24	20	0.08	0.50	0.38

Hay

Alfalfa		4 tons	180	40	180	112	12	19	0.06	0.44	0.42
Bluegrass		2 tons	60	20	60	16	7	5	0.02	0.30	0.08
Coastal bermudagrass		8 tons	300	70	270	59	24	35	0.21	-	-
Red clover		2.5 tons	100	25	100	69	17	7	0.04	0.54	0.36
Soybean		2 tons	90	20	50	40	18	10	0.04	0.46	0.15
Timothy		2.5 tons	60	25	95	18	6	5	0.03	0.31	0.20

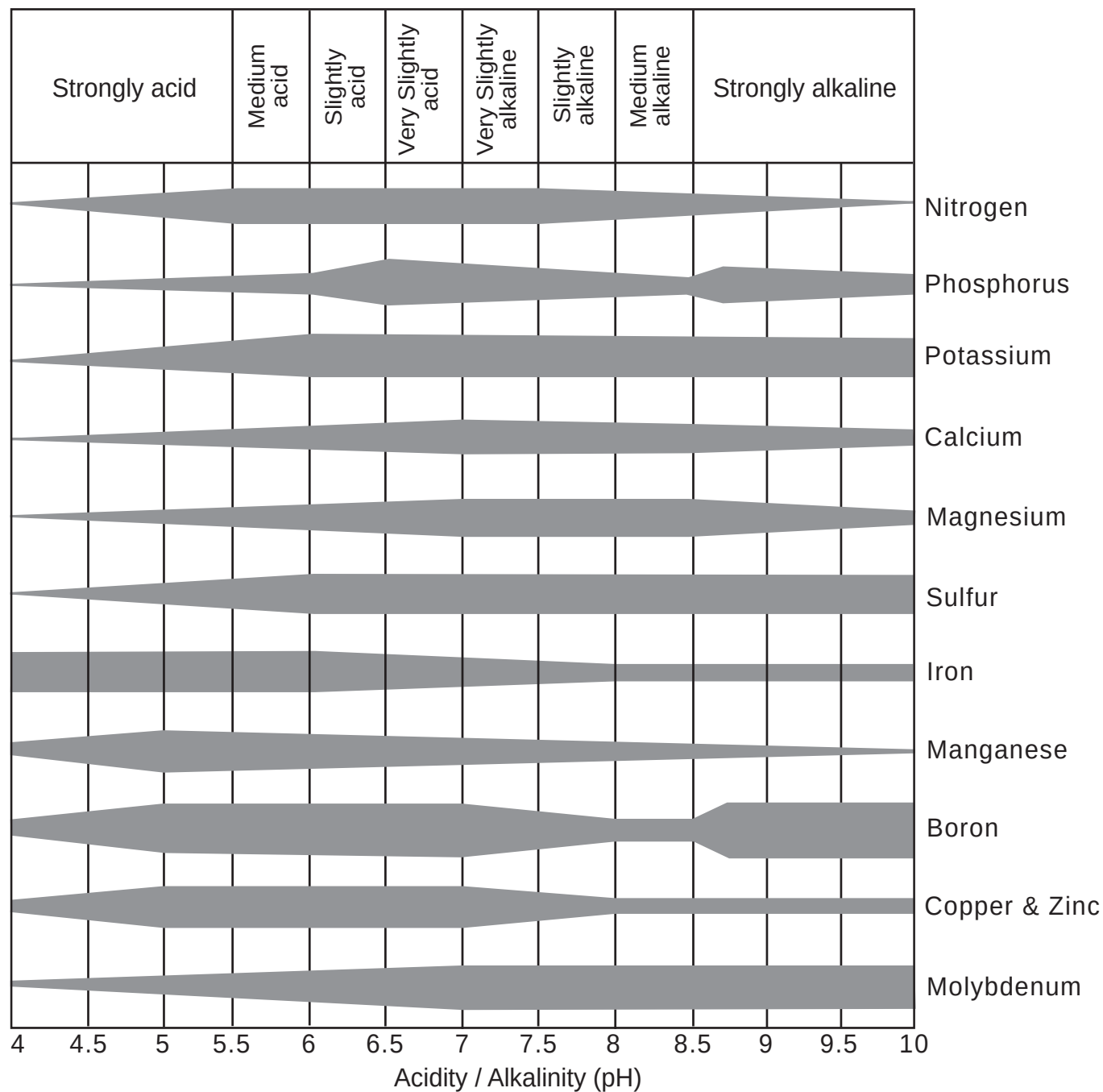
Fruits, Vegetables

Apples		500 bu	30	10	45	8	5	10	0.03	0.03	0.03
Cabbage		20 tons	130	35	130	20	8	44	0.04	0.10	0.08
Grapes	fruit	5 tons	15	10	25	-	-	-	-	-	-
Grapes	leaves & wood		20	5	20	-	-	-	-	-	-
	Total		35	15	45	-	-	-	-	-	-
Muskmelon	fruit	7 tons	30	11	60	-	-	-	-	-	-
Muskmelon	vines	1.5 tons	20	5	30	-	-	-	-	-	-
	Total		50	15	90	-	-	-	-	-	-
Peaches		600 bu	35	20	65	4	8	2	-	-	0.01
Potatoes	tubers	400 bu	80	30	150	3	6	6	0.04	0.09	0.05
Sweet potatoes	roots	300 bu	45	15	75	4	9	6	0.03	0.06	0.03
Tomatoes	fruit	20 tons	120	40	160	7	11	14	0.07	0.13	0.16

General Crop Nutrient Deficiency Symptoms

Nutrient	Deficiency Symptoms*
Nitrogen (N)	Restricted growth of tops and roots; growth upright and spindly; leaves pale and yellowish-green in early stages, more yellow and even orange or red in later stages; deficiency shows up first on lower leaves.
Phosphorus (P)	Restricted growth of tops and roots; growth is upright and spindly; leaves bluish-green in early stages with green color sometimes darker than plants supplied with adequate phosphorus; more purplish in later stages with occasional browning of leaf margins; defoliation is premature, starting at the older leaves.
Potassium (K)	Browning of leaf tips; marginal scorching of leaf edges; development of brown or light colored spots in some species which is usually more numerous near the margins; deficiency shows up first on lower foliage.
Calcium (Ca)	Deficiency occurs mainly in younger leaves near the growing point; younger leaves distorted with tips hooked back and margins curled backward or forward; leaf margins may be irregular and display brown scorching or spotting.
Magnesium (Mg)	Interveneal chlorosis with chlorotic areas separated by green tissue in earlier stages giving a beaded streaking effect; deficiency occurs first on lower foliage.
Sulfur (S)	Younger foliage is pale yellowish-green, similar to nitrogen deficiency; shoot growth somewhat restricted.
Zinc (Zn)	Interveneal chlorosis followed by die back of chlorotic areas.
Manganese (Mn)	Light green to yellow leaves with distinctly green veins; in severe cases, brown spots appear on the leaves and the leaves are shed; usually begins with younger leaves.
Boron (B)	Growing points severely affected; stems and leaves may show considerable distortion; upper leaves are often yellowish red and may be scorched or curled.
Copper (Cu)	Younger leaves become pale green with some marginal chlorosis.
Iron (Fe)	Interveneal chlorosis of younger leaves.
Molybdenum (Mo)	Leaves become chlorotic, developing rolled or cupped margins; plants deficient in this element often become nitrogen deficient.
Chlorine (Cl)	Deficiency not observed under field conditions.

**Relationship Between Soil pH and the Availability of Minerals
That Are Essential for Plant Growth.**
The Varying Thickness of Each Band Indicates the Availability of the Minerals. ^a



^aThe Nature and Properties of Soils 12th ed. Nyle C. Brady and Ray R. Weil. Prentice Hall. Pg. 36.

Revised from N. A. Pettinger's, "A Useful Chart for Teaching the Relation of Soil Reaction to the Availability of Plant Nutrients to Crops", Virginia Polytechnic Institute, March, 1935.

Soil Testing Lab Conversion Factors

Periodically we in Extension receive requests for **information on interpretation** of soil test results from laboratories which use procedures that are different than ours. Very simply, different procedures usually extract different amounts of nutrients from the soil. However, any good soil testing procedure, when properly correlated with plant growth, can be used as a basis for making fertilizer recommendations. In the Virginia Tech Soil Testing Laboratory, we use the Mehlich 1 (0.05N HCl + 0.025N H₂SO₄) soil test procedure to extract both phosphorus and potassium since we have done considerable research to correlate test results obtained by this method with plant growth. Other procedures, however, may extract more or less nutrients than the Mehlich 1 procedure does, and therefore, values obtained by these other methods cannot be used directly to make fertilizer recommendations. **They must first be converted to equivalent Virginia Tech test levels.**

The following are **conversion factors** for converting private and other state lab phosphorus and potassium test results to Virginia Tech test values. The conversion factors are approximate values only and they vary depending on soil type, type of clay, past fertilization, etc. However, they should put one in the “ballpark” with respect to Virginia Tech test levels.

1. Converting Bray P₁ (Weak Bray) Phosphorus to Virginia Tech Mehlich 1 Phosphorus

pH < 5.6	Weak Bray P, ppm x 0.6 = Virginia Tech P, ppm Weak Bray P, ppm x 1.2 = Virginia Tech P, lb/A
pH 5.6 – 6.2	Weak Bray P, ppm x 0.7 = Virginia Tech P, ppm Weak Bray P, ppm x 1.4 = Virginia Tech P, lb/A
pH 6.3 – 6.9	Weak Bray P, ppm x 0.8 = Virginia Tech P, ppm Weak Bray P, ppm x 1.6 = Virginia Tech P, lb/A
pH > 6.9	Weak Bray P, ppm x 1.2 = Virginia Tech P, ppm Weak Bray P, ppm x 2.4 = Virginia Tech P, lb/A

2. Converting Ammonium Acetate Potassium to Virginia Tech Mehlich 1 Potassium

Ammonium Acetate K, ppm x 0.67 = Virginia Tech K, ppm
Ammonium Acetate K, ppm x 1.33 = Virginia Tech K, lb/A

3. Converting Mehlich 3 Phosphorus to Virginia Tech Mehlich 1 Phosphorus

Preliminary research indicates that, for Mid-Atlantic soils, the Mehlich 3 phosphorus procedure extracts approximately the same amount of phosphorus as the Bray P₁ (Weak Bray) procedure. Therefore, use the same conversion factor as given for Bray P₁ to convert Mehlich 3 phosphorus to Virginia Tech phosphorus.

4. Converting Mehlich 3 Potassium to Virginia Tech Mehlich 1 Potassium

Preliminary research indicates that, for Mid-Atlantic soils, the Mehlich 3 potassium procedure extracts approximately the same amount of potassium as the ammonium acetate procedure. Therefore, use the same conversion factor as given for ammonium acetate to convert Mehlich 3 potassium to Virginia Tech potassium.

5. Calibration of Phosphorus (P) and Potassium (K) Tests, Virginia Tech Soil Testing Laboratory

Soil Test P	lb/A	P-ppm
L-	0-3	0-2
L	4-8	2-4
L+	9-11	5-6
M-	12-20	6-10
M	21-30	11-15
M+	31-35	16-18
H-	36-55	18-28
H	56-85	28-43
H+	86-110	43-55
VH	110+	55+

Soil Test K	lb/A	K-ppm
-	0-15	0-8
L	16-55	8-28
+	56-75	28-38
M-	76-100	38-50
M	101-150	51-75
M+	151-175	76-88
H-	176-210	88-105
H	211-280	106-140
H+	281-310	141-155
VH	310+	155+

6. Other Useful Conversion Factors

P	x	2.3	=	P ₂ O ₅
P ₂ O ₅	x	0.44	=	P
K	x	1.2	=	K ₂ O
K ₂ O	x	0.83	=	K
ppm	x	2.0	=	lbs/A
lbs/A	x	0.5	=	ppm

PART VIII

Fertilizers

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Composition of Principle Fertilizer Materials

	Nitrogen (N)	Phosphate (P ₂ O ₅)	Potash (K ₂ O)	Physical State
Material Supplying	%	%	%	
Nitrogen				
Ammonium nitrate	33-34	0	0	solid
Anhydrous ammonia	82	0	0	gas
Ammonium thiosulfate	12	-	26	liquid
Calcium nitrate	15	0	0	solid
Sodium nitrate	16	0	0	solid
Urea-ammonium nitrate	28-32	0	0	liquid
Ammonium sulfate	21	0	0	solid
Urea	45-46	0	0	solid
Phosphorus				
Ammonium polyphosphate (APP)	10	34-37	0	liquid
Diammonium phosphate (DAP)	18-21	46-53	0	solid
Ground bone (raw)	2.5 to 4	20-25	0	solid
Ground rock phosphate	0	25-40 (14-65% avail.)	0	solid
Monammonium phosphate (MAP)	11-13	48-62	0	solid
Steamed bone meal	1 to 2.5	22-30	0	solid
Superphosphate, normal	0	16-22	0	solid
Superphosphate, triple	0	44-53	0	solid
Potassium				
Muriate of potash (potassium chloride)	0	0	60-62	solid
Potassium nitrate	13	0	44	solid
Potassium sulfate	0	0	50-53	solid
Potassium thiosulfate	-	0	25	liquid
Potassium orthophosphate	-	30-50		
Potassium magnesium sulfate	0	0	22	solid

Sources of calcium, magnesium, sulfur, and micronutrients

Calcium sources		
Material	Chemical Formula	% Ca
Calcitic lime	CaCO_3	31.7
Calcium nitrate	$\text{Ca}(\text{NO}_3)_2$	19.4
Dolomitic lime	$\text{CaCO}_3 + \text{MgCO}_3$	21.5
Gypsum	$\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$	22.5
Hydrated lime	$\text{Ca}(\text{OH})_2$	46.1
Marl	CaCO_3	24.0
Superphosphate, normal	$\text{Ca}(\text{H}_2\text{PO}_4)_2$	20.4
Superphosphate, triple	$\text{Ca}(\text{H}_2\text{PO}_4)_2$	13.6
Sulfur sources		
Material	Chemical Formula	% S
Ammonium sulfate	$(\text{NH}_4)_2\text{SO}_4$	24
Gypsum	$\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$	16.8
K-Mg-sulfate	$\text{K}_2\text{SO}_4 \cdot 2\text{MgSO}_4$	22.0
Sulfur, elemental	S	32-33
Potassium thiosulfate	$(\text{NH}_4)_2\text{S}_2\text{O}_3$	17
Ammonium thiosulfate	$\text{K}_2\text{S}_2\text{O}_3$	26
Boron sources		
Material	Chemical Formula	% B
Boron frits	Frit	10-17
Borax	$\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$	11
Boric acid	H_3BO_3	17
Sodium pentaborate	$\text{Na}_2\text{B}_{10}\text{O}_{16} \cdot 10\text{H}_2\text{O}$	18
Sodium tetraborate		
Fert. borate-46	$\text{Na}_2\text{B}_4\text{O}_7 \cdot 5\text{H}_2\text{O}$	14
Fert. borate-65	$\text{Na}_2\text{B}_4\text{O}_7$	20
Solubor	$\text{Na}_2\text{B}_{10}\text{O}_{16} \cdot 10\text{H}_2\text{O}$ + $\text{Na}_2\text{B}_4\text{O}_7 \cdot 5\text{H}_2\text{O}$	20
Molybdenum sources		
Material	Chemical Formula	% Mo
Ammonium molybdate	$(\text{NH}_4)_6\text{Mo}_7\text{O}_{24} \cdot 2\text{H}_2\text{O}$	54
Molybdenum trioxide	MoO_3	66
Molybdenum frit	Frit	1-30
Sodium molybdate	$\text{Na}_2\text{MoO}_4 \cdot 2\text{H}_2\text{O}$	39
Copper sources		
Material	Chemical Formula	% Cu
Copper ammonium phosphate	$\text{Cu}(\text{NH}_4)\text{PO}_4 \cdot \text{H}_2\text{O}$	32
Copper chelates	Na_2CuEDTA NaCuHEDTA	13 9
Copper frits	Frit	40-50
Copper sulfate	$\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$	25
Magnesium sources		
Material	Chemical Formula	% Mg
Dolomitic lime	$\text{MgCO}_3 + \text{CaCO}_3$	11.4
Epsom salt	$\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$	9.6
Magnesia	MgO	55.0
Potassium-magnesium sulfate	$\text{K}_2\text{SO}_4 \cdot 2\text{MgSO}_4$	11.2
Manganese sources		
Material	Chemical Formula	% Mn
Manganese chelate	MnEDTA	12
Manganese sulfate	$\text{MnSO}_4 \cdot 4\text{H}_2\text{O}$	26-28
Manganese frit	Frit	35
Manganese oxide	MnO	41-68
Zinc sources		
Material	Chemical Formula	% Zn
Zinc carbonate	ZnCO_3	52
Zinc chelates	Na_2ZnEDTA NaZnHEDTA	14 9
Zinc oxide	ZnO	78
Zinc sulfate	$\text{ZnSO}_4 \cdot \text{H}_2\text{O}$	35
Iron sources		
Material	Chemical Formula	% Fe
Iron sulfate	$\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$	19
Iron ammonium phosphate	$\text{Fe}(\text{NH}_4)\text{PO}_4 \cdot \text{H}_2\text{O}$	29
Iron ammonium polyphosphate	$\text{Fe}(\text{NH}_4)\text{HP}_2\text{O}_7$	22
Iron frits	Frit	30-40
Iron chelates	NaFeEDTA NaFeDTPA NaFeEDDHA	5-14 10 6

Conversion factors

Converting the percentage of one material to percentage of another may be done easily with a conversion factor, some of which are listed below. For example, to convert the percentage of K to K_2O , multiply the percentage of K by 1.2051; in like manner, the percentage of K_2O may be converted to K by multiplying the percentage of K_2O by 0.8301.

K to K_2O	multiply K	by 1.2051
K_2O to K	multiply K_2O	by 0.8301
KCl to K	multiply KCl	by 0.5244
KCl to Cl	multiply KCl	by 0.4756
K_2SO_4 to K	multiply K_2SO_4	by 0.4487
Mg to MgO	multiply Mg	by 1.6578
MgO to Mg	multiply MgO	by 0.6032
$MgCO_3$ to MgO	multiply $MgCO_3$	by 0.4782
MgO to $MgCO_3$	multiply MgO	by 2.0913
$MgSO_4$ to Mg	multiply $MgSO_4$	by 0.2020
$MgCO_3$ to $CaCO_3$	multiply $MgCO_3$	by 1.1867
CaO to Ca	multiply CaO	by 0.7147
Ca to CaO	multiply Ca	by 1.3992
$CaCO_3$ to $MgCO_3$	multiply $CaCO_3$	by 0.8426
$CaCO_3$ to CaO	multiply $CaCO_3$	by 0.5603
K_2SO_4 to S	multiply K_2SO_4	by 0.1840
$CaSO_4$ to Ca	multiply $CaSO_4$	by 0.2938
$CaSO_4$ to S	multiply $CaSO_4$	by 0.2350
SO_4 to S	multiply SO_4	by 0.3339
S to SO_4	multiply S	by 2.9963
NaCl to Cl	multiply NaCl	by 0.6066
N to NH_3	multiply N	by 1.2158
N to KNO_3	multiply N	by 7.2162
NH_3 to N	multiply NH_3	by 0.8225
N to $(NH_4)_2SO_4$	multiply N	by 4.7160
$(NH_4)_2SO_4$ to N	multiply $(NH_4)_2SO_4$	by 0.2120
$(NH_4)_2SO_4$ to S	multiply $(NH_4)_2SO_4$	by 0.2427
N to NH_4NO_3	multiply N	by 2.8571
NH_4NO_3 to N	multiply NH_4NO_3	by 0.3500
P to P_2O_5	multiply P	by 2.2910
P_2O_5 to P	multiply P_2O_5	by 0.4365