

INSTRUCTION MANUAL

FOR DCL-12, 13, 14, 15, 20



Helping People Solve Analytical Challenges®

PO Box 329 • Chestertown • Maryland • 21620 • USA

800-344-3100 • 410-778-3100 (Outside U.S.A.)

Visit us on the web at www.lamotte.com

TABLE OF CONTENTS

	Page
Introduction to Colorimetric Analysis	3
Sample Dilution Techniques	4
General Information	5
Specifications	6
General Operating Procedure	7
pH-Lime Requirement	8
Soluble Salts	9
Soil Colorimeter Tests	10
Ammonia Nitrogen	11
Calcium & Magnesium	12 - 13
Chloride	14
Copper	15
Iron	16
Manganese	17 - 18
Nitrate Nitrogen	19 - 20
Nitrite Nitrogen	21 - 22
Phosphorus	23 - 24
Potassium	25 - 26
Sulfur	27 - 28
Zinc	29 - 30

AN INTRODUCTION TO COLORIMETRIC ANALYSIS

Most test substances in water are colorless and undetectable to the human eye. In order to test for their presence we must find a way to "see" them. The LaMotte colorimeter can be used to measure any test substance that is itself colored or can be reacted to produce a color. In fact a simple definition of colorimetry is "the measurement of color" and a colorimetric method is "any technique used to evaluate an unknown color in reference to known colors". In a colorimetric chemical test the intensity of the color from the reaction must be proportional to the concentration of the substance being tested. Some reactions have limitations or variances inherent to them that may give misleading results. Many such interferences are discussed with each particular test instruction. In the most basic colorimetric method the reacted test sample is visually compared to a known color standards. However, accurate and reproducible results are limited by the eyesight of the analyst, inconsistencies in the light sources, and the fading of color standards.

To avoid these sources of error, a colorimeter can be used to photoelectrically measure the amount of colored light absorbed by a colored sample in reference to a colorless sample (blank).

Why measure colored light? White light is made up of many different colors or wavelengths of light. A colored sample typical absorbs only one color or one band of wavelengths from the white light. Not much difference could be measured between white light before it passes through a colored sample versus after it passes through. The reason for this is that the one color absorbed by the sample is only a small portion of the total amount of light passing through the sample. However, if we could select only that one color or band of wavelengths of light which the test sample is most sensitive to, we would see a large difference between the light before it passes through the sample and after it passes through.

A colorimeter passes a white light beam through an optical filter which transmits only one particular color or band of wavelengths of light to the photodetector where it is measured. The difference in the amount of colored light transmitted by a colorless sample (blank) and the amount of colored light transmitted by a colored sample is a measurement of the amount of colored light absorbed by the sample. In most colorimetric tests the amount of colored light absorbed is directly proportional to the concentration of the test factor producing the color and the path length through the sample. However, for some tests the amount of colored light absorbed is inversely proportional to the concentration.

The choice of the correct optical filter and therefore the correct color or wavelength of light is important. It is interesting to note that the filter that gives the most sensitive calibration for your test factor is the complimentary color of the test sample. For example, the Nitrate-Nitrogen test produces a pink color proportional to the nitrate concentration in the sample (the greater the nitrate concentration, the darker the pink color). A green filter is used since a pinkish-red solution absorbs mostly green light.

REAGENT BLANK

Some tests will provide greater accuracy if a reagent blank is determined, to compensate for any color or turbidity resulting from the reagents themselves. A reagent blank is performed by running the test procedure on 10 mL of demineralized water. With the reagent blank in the colorimeter chamber, scan the blank then perform the unknown tests as described.

COLORIMETER TUBES

Colorimeter tubes which have been scratched through excess use should be discarded and replaced with new ones. Dirty tubes should be cleaned on both the inside and outside. Fingerprints on the exterior of the tubes can cause excessive light scattering and result in errors. Handle the tubes carefully, making sure the bottom half of the tube is not handled.

LaMotte makes every effort to provide high quality colorimeter tubes. However, wall thicknesses and diameter of tubes may still vary slightly. This may lead to slight variations in results (e.g. if a tube is turned while in the sample chamber, the reading will likely change slightly). To eliminate this error put the tubes into the colorimeter chamber with the same orientation every time.

The tubes that are included with the colorimeter have an index mark to facilitate this.

SAMPLE DILUTION TECHNIQUES

If a test result exceeds the lower end of the calibration chart for a specific test, you must dilute your sample. Repeat the test to obtain a reading which is in the concentration range for the test. The reading is multiplied by the appropriate dilution factor. If the reading exceeds the high end of the calibration chart, a reagent blank should be run for best results. (Note: These comments are not true for colorimetric determination of pH.)

EXAMPLE: Measure 5 mL of the water sample into a graduated cylinder. Add demineralized water until the cylinder is filled to the 10 mL line. The sample has been diluted by one-half, and the dilution factor is therefore 2. Perform the test procedure, then multiply the resulting concentration by 2 to obtain the test result.

The following table gives quick reference guidelines on dilutions of various proportions. All dilutions are based on a 10 mL volume, so several dilutions will require small volumes of the water sample. Graduated pipets should be used for all dilutions.

SIZE OF SAMPLE	DEIONIZED WATER TO BRING VOLUME TO 10 ML	MULTIPLICATION FACTOR
10 mL	0 mL	1
5 mL	5 mL	2
2.5 mL	7.5 mL	4
1 mL	9 mL	10
0.5 mL	9.5 mL	20

If the above glassware is not available, dilutions can be made with the colorimeter tube. Fill the colorimeter tube to the 10 mL line with the sample then transfer it to another container. Add 10 mL volumes of demineralized water to the container and mix. Transfer back 10 mL of the diluted sample to the colorimeter tube and test it. Continue diluting and testing until a reading, which is in the concentration range for the test, is obtained. Be sure to multiply the concentration found by the dilution factor (the number of total 10 mL volumes used).

EXAMPLE: 10 mL of sample is diluted with three 10 mL volumes of demineralized water; the dilution factor is four.

INTERFERENCES

LaMotte reagents systems are designed to minimize most common interferences. Each individual test discusses interferences unique to that test. You should be aware of possible interferences in the water being tested.

The reagent systems also contain buffers to adjust the water sample to the ideal pH for the reaction. It is possible that the buffer capacity of the water sample may exceed the buffer capacity of the reagent system and the ideal pH will not be obtained. If this is suspected, measure the pH of a reacted distilled water reagent blank using a pH meter. This is the ideal pH for the test. Measure the pH of a reacted water sample using the pH meter. If the pH is significantly different from the ideal value, the pH of the sample should be adjusted before testing.

Interferences due to high concentration of the substance being tested for, can be over come by sample dilution.

STRAY LIGHT INTERFERENCE

Normal indoor lighting causes no interference with the DC1600 Colorimeter. Testing in bright sunlight may result in interferences due to stray light. This interference can be eliminated by covering the colorimeter chamber with the black cap when zeroing the meter and reading samples. Turbidimetric determinations (i.e. sulfate, potassium, cyanuric acid and turbidity) are most likely to exhibit a stray light interference. Always check for stray light interferences when you do turbidimetric determinations. Colorimetric test are less likely to have this problem.

To determine if stray light is causing an interference place a reacted sample in the colorimeter chamber. Press the "30 Second Read" button. As soon as the reading stabilizes (usually 5–7 seconds), record the reading. Cover the colorimeter chamber with something (i.e. a hand or any opaque object), if the reading changes then there is an interference. If the reading changes only 1 - 2 % T then the interference is negligible except for the most critical tests. If sample turbidity is causing a stray light interference a filtration may be needed.

GENERAL INFORMATION

LIMITS OF LIABILITY

Under no circumstances shall LaMotte Company be liable for loss of life, property, profits, or other damages incurred through the use or misuse of their products.

PACKAGING AND DELIVERY

Experienced packaging personnel at LaMotte Company assure the adequate protection against normal hazards encountered in transportation of shipments. After the product leaves the manufacturer, all responsibility for its safe delivery is assured by the transportation company. Damage claims must be filed immediately with the transportation company to receive compensation for damaged goods.

Should it be necessary to return the instrument for repair or servicing, pack instrument carefully in suitable container with adequate packing material. Attach a letter to the shipping carton describing the kind of trouble experienced. This valuable information will enable the service department to make the required repairs more efficiently.

EPA COMPLIANCE

The DC1600 Colorimeter is an EPA-Accepted instrument. EPA-Accepted means that the instrument meets the requirements for colorimeters as found in test procedures that are approved for the National Primary Drinking Water Regulations (NPDWR) or National Pollutant Discharge Elimination System (NPDES) compliance monitoring programs. EPA-Accepted instruments may be used with approved test procedures without additional approval.

REPLACING LIGHT BULB

Turn the meter over, making sure the battery compartment is in the upper left corner (This is important). Remove the four screws from the bottom of the colorimeter and remove the base. The burned out light bulb is attached to the small rectangular circuit located just to the right (your right) of the light chamber. Remove the two screws that connect the circuit and SAVE THE BURNED OUT LIGHT BULB. The light bulb must be returned to LaMotte Company for replacement. Make sure the two washers are still in place. Remove the screw in the upper left corner of the colorimeter and detach the replacement circuit. Replace that screw. When fastening the fresh bulb in place, be sure both washers are aligned. Align the base to the meter and replace the four original screws.

NOTE: If the replacement bulb is significantly different from the original bulb, the "Set Blank" control may not have enough range; if so, please call our technical support people for assistance.

REPLACING THE BATTERY

The colorimeter is equipped with a battery check indication, the symbols BAT and ~ on the left hand side of the display, that will be displayed when the battery needs to be replaced. The meter will still provide valid readings, but the readings may drift. Eventually the meter will not have enough power to turn on. To replace the battery, remove the panel on the back of the meter and detach the battery. Replace with a fresh alkaline 1604A type (9V) battery.

Battery polarity (+ & -) must never be reversed, even momentarily. If it is, the instrument will be rendered INOPERABLE, and must be returned to LaMotte Company for repair. This will be considered a non-warranty repair. Use appropriate caution when replacing the battery.

SPECIFICATIONS

INSTRUMENT TYPE

Multi-wavelength filter colorimeter – internal, non-removable filters

READOUT

3½ inch digit LCD; displays 0–100%T

READABLE RESOLUTION

± 1%T

READING STABILITY

± 0.2%T within 5 seconds of turn-on to automatic turn-off

READING INTERVAL

Approximately 30 seconds with automatic turn-off, resettable

MEASUREMENT WAVELENGTHS

1 (420nm), 2 (460nm), 3 (510nm), 4 (530nm), 5 (570nm), 6 (605nm); switch selectable

WAVELENGTH ACCURACY

± 1 nanometers

PHOTOMETRIC ACCURACY

± 0.5%T

SAMPLE CHAMBER

Indexed; accepts 21 mm diameter flat-bottomed test tubes (capped)

SOURCE LAMP

Tungsten filament bulb, 10,000 hour life (est.), spare included, field replaceable

POWER REQUIREMENTS

Battery Operation: Field replaceable 1604 type (9V)

Line Operation: 120/220V, 50/60 Hz, 2VA, with optionally-available adapter

DIMENSIONS

(W x D x H) 190 x 140 90 mm

7½ x 5½ x 3½ inches

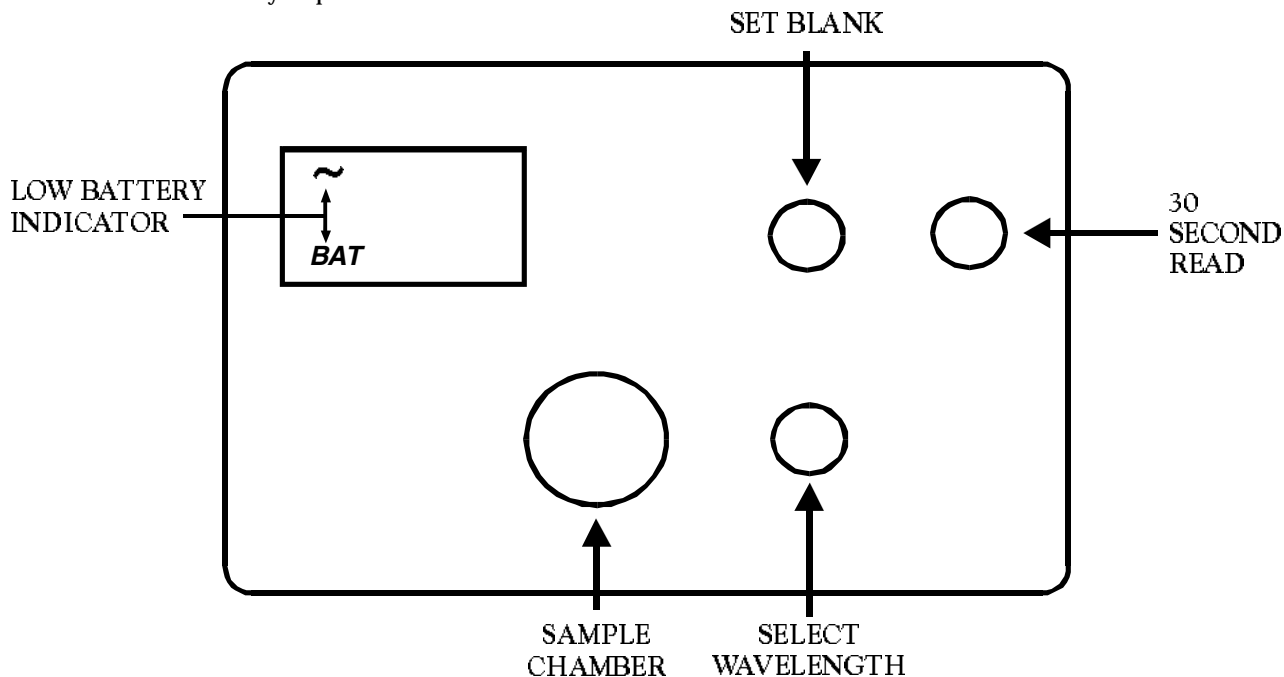
WEIGHT

2 lbs.

GENERAL OPERATING PROCEDURE

1. Rinse a clean colorimeter tube (0967) with sample water. Fill to the 10 mL line with sample.
2. Select the appropriate wavelength (1 to 7) from the "Select Wavelength" knob. Insert tube into the colorimeter chamber. (Press firmly on the tube, overcoming the slight resistance, to make sure the tube rests on the bottom of the chamber.)
3. Press the "30 Second Read" button (the BAT and ~ symbols will flash on briefly). Adjust instrument with "Set Blank" control until meter reads exactly 100%T. The instrument is now ready to read an unknown sample.

NOTE: See Battery Replacement section for more information.



4. Perform test outlined in the recommended procedures.
5. Insert sample into the colorimeter and press the "30 Second Read" button. As soon as the reading stabilizes (usually 5–7 seconds), record the reading.
6. Consult the calibration chart for the corresponding concentration. For example, a reading of 75%T would be found by reading 70%T on the left column of the chart and 5 across the top of the chart. Read down the column until the columns intersect. The value at the intersection represents concentration in parts per million (ppm) or milligrams per liter (mg/L).

TYPICAL CALIBRATION CHART

%T	9	8	7	6	5	4	3	2	1	0
90										
80										
70			0.00	0.01	0.01	0.02	0.02	0.02	0.03	0.03
60	0.04	0.04	0.04	0.05	0.05	0.06	0.06	0.06	0.07	0.07
50	0.08	0.08	0.08	0.09	0.09	0.10	0.10	0.10	0.11	0.11
40	0.11	0.12	0.12	0.13	0.13	0.13	0.14	0.14	0.14	0.15
30	0.15	0.16	0.16	0.16	0.17	0.17	0.18	0.18	0.19	0.19
20	0.20	0.20	0.21	0.22	0.22	0.23	0.24	0.25	0.26	0.27
10	0.28	0.30								

NOTE: The number of decimal places in each number in the calibration chart is provided for interpolation purposes only and does not necessarily reflect the sensitivity of each test.

NOTE: %T readings above the highest %T value on the chart should be interpreted as 0 ppm. For example, on the above chart, readings above 77%T would correspond to 0 ppm. Some tests may have results above 100%T.

pH

PROCEDURE

1. Use the 10 g Soil Measure (1164) to add one level measure of the soil sample to a 50 mL beaker (0944). Use the graduated cylinder (0416) to add 10 mL of deionized water. Stir thoroughly.
2. Let stand for at least 30 minutes, stirring two or three times.
3. Read pH on pH meter. Stir mixture just prior to making the pH reading.

LIME REQUIREMENT - WOODRUFF METHOD

PROCEDURE

1. Use the 10 g Soil Measure (1164) to add one level measure of the soil sample to a 50 mL beaker (0944). Use the graduated cylinder (0416) to add 10 mL of deionized water. Stir thoroughly.
2. Let stand for at least 15 minutes.
3. Add 20 mL of Woodruff Buffer Solution (5272). Mix well, and let stand for at least 20 minutes, stirring two or three times.
4. Read on pH meter. Stir mixture just prior to making reading.
5. Each 0.1 pH unit drop from pH 7.0 indicates a lime requirement equivalent to 1000 lbs calcium carbonate (CaCO_3).

SOLUBLE SALTS (TOTAL DISSOLVED SALTS)

PROCEDURE

1. Fill a 50 mL beaker (0944) with the soil to be tested, tapping it lightly to eliminate any trapped air and then strike off the surface.
2. Empty the contents of the beaker into the 300 mL bottle (0991) and add 100 mL of deionized water.
3. Cap the bottle and shake vigorously. Allow to stand for thirty minutes. During the thirty minute waiting period the bottle should be shaken vigorously three or four times.
4. Filter the contents of the bottle using funnel (0459) and filter paper (0463) and collect the filtrate in a 100 mL bottle (0990) which is then used as a conductivity chamber.
5. Take conductivity reading according to method given for General Operating Procedure.
6. To convert conductivity to Soluble Salts (Total Dissolved Salts), use the following formula.

$$\text{Micromhos/cm @ 25°C} \times 0.7 = \text{ppm of soluble salts (total dissolved salts)}$$

SOLUBLE SALTS

Below 1000 parts per million most plants will get along well. However, green-house and many sensitive garden plants may be damaged if the soluble salts are over 500 parts per million of chlorides, particularly some of the most sensitive legumes. If the soluble salts are greater than 1000 parts per million, the chlorides and sulfates should be determined to learn whether the soluble salts are chlorides or sulfates. In calcareous soils, the sulfates represent gypsum and have little effect on the production of plants.

SOIL COLORIMETER TESTS

INSTRUCTIONS

pH and Lime Requirement are determined by means of the pH meter. The conductivity meter is used for determining soluble salts. Calcium, Magnesium and Chlorides are determined by titration. All of the other readings are made on the colorimeter.

EXTRACTION

The following method of extraction is employed for obtaining the soil filtrate for the tests for Nitrate Nitrogen, Phosphorous, Potassium, Calcium, Magnesium, Ammonia Nitrogen, Nitrite Nitrogen, Manganese, Copper, Zinc, and Iron. Separate extractions are required for the Chloride and Sulfate tests. Consult the LaMotte Soil Handbook for information on sampling and preparation of sample for testing.

PROCEDURE

1. Use the 1 mL pipet (0354) to add 5 mL of the *Acid Extracting Solution (6361) to the 100 mL graduated cylinder (0419). Add deionized water to 75 mL graduation.
2. Pour this solution into the 100 mL bottle (0990).
3. Use the Soil Measure (1165) to add 15 g (one level measure) of the soil sample to the bottle.
4. Cap the bottle and shake for a period of 5 minutes.
5. Use the funnel (0459) and filter paper (0463) to filter and collect all of the soil filtrate in a 100 mL bottle (0990).
6. The soil filtrate is used for all of the tests listed above, except Chloride and Sulfate.

SINGLE TEST PROCEDURE

1. Use the 1 mL pipet (0354) to add 1 mL of the *Acid Extracting Solution (6361) to the graduated vial (0989), then add deionized water to the graduation.
2. Use the 1.0 g spoon (0697) to add 3 grams of soil to the extracting solution in the vial.
3. Cap the vial and shake for a period of 5 minutes.
4. Filter, using the funnel (0459) and filter paper (0463) and collect all of the soil filtrate.
5. The soil filtrate is used for all of the tests except Chlorides and Sulfates.

NEUTRALIZATION OF SOIL FILTRATE

In the tests for Calcium, Magnesium, Ammonia Nitrogen, Manganese, Copper, Zinc, and Iron the acidity of the soil filtrate must be neutralized before proceeding with the test. This is done by treating the measured soil filtrate with *Sodium Hydroxide, 15% (7886) until the solution shows a green or blue color when spotted on a strip of Bromthymol Blue Test Paper (2931). This is done by adding the *Sodium Hydroxide, 15% (7886) solution to the soil filtrate, one drop at a time while stirring with the plastic rod (0824). The stirring rod is touched to the Bromthymol Blue test paper after the addition of each drop of *Sodium Hydroxide, 15% (7886), until the color changes from yellow to green or blue.

AMMONIA NITROGEN TEST NESSLERIZATION METHOD

QUANTITY	CONTENTS	CODE
30 mL	Ammonia Nitrogen Reagent #1	V-4797-G
2 x 30 mL	*Ammonia Nitrogen Reagent #2	*V-4798-G
1	Pipet, 1 mL, plastic	0354

***WARNING:** Reagents marked with a * are considered hazardous substances. Material Safety Data Sheets (MSDS) are supplied for these reagents. For your safety read label and MSDS before using.

A fertile soil may be expected to give a low ammonia nitrogen test reading, unless there has been a recent application of nitrogenous fertilizer in forms other than the nitrate. The rapid disappearance of ammonia after fertilizer application indicates the desired transformation of the ammonia to the more available nitrate compounds. In forest soils, ammonia is the most abundant available form of nitrogen. If there is a satisfactory rate of nitrogen transformation, the humus layers of a forest soil will produce very high concentrations of ammonia nitrogen.

RANGE: 0-150 lbs/A

METHOD: Ammonia forms a colored complex with Nessler's Reagent in proportion to the amount of ammonia present in the sample. Rochelle salt is added to prevent precipitation of calcium or magnesium in undistilled samples.

INTERFERENCES: Sample turbidity and color may interfere. Turbidity may be removed by filtration procedure. Color interferences may be eliminated by adjusting the instrument to 100%T with a sample blank.

PROCEDURE

1. Use the 1 mL pipet (0354) to transfer 2 mL of soil filtrate into a clean colorimeter tube (0967) and dilute to the 10 mL mark with deionized water. Mix and neutralize according to the procedure on page 10.
2. Select setting 1 on the "Select Wavelength" knob.
3. Insert sample into chamber and press the "30 Second Read" button. Adjust "100"%T with the "Set Blank" knob.
4. Remove sample tube and add 12 drops of Ammonia Nitrogen Reagent #1 (4797), cap and mix.
5. With the 1.0 mL pipet (0354), add one measure of *Ammonia Nitrogen Reagent #2 (4798) to the tube, cap and mix. Allow five minutes for maximum color development.
6. At the end of a 5 minute waiting period, insert sample into colorimeter, press "30 Second Read" button and measure %T as soon as reading stabilizes.
7. Consult chart to find the concentration of Ammonia Nitrogen in pounds per acre.

AMMONIA NITROGEN CALIBRATION CHART (LBS/ACRE)

%T	9	8	7	6	5	4	3	2	1	0
80			0.0	0.5	1.5	2.0	3.0	3.5		
70	4.5	5.5	6.0	7.0	8.0	8.5	9.5	10.5	11.5	12.0
60	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0	21.0	22.0
50	23.0	24.0	25.5	26.5	27.5	28.5	30.0	31.0	32.5	33.5
40	35.0	36.0	37.5	39.0	40.5	42.0	43.0	44.5	46.5	48.0
30	49.5	51.0	53.0	54.5	56.5	58.0	60.0	62.0	64.0	66.0
20	68.5	70.5	73.0	75.5	78.0	80.5	83.5	86.0	89.0	92.0
10	95.5	99.0	102.5	106.5	110.5	115.0	120.0	125.0	130.5	137.0
0	143.5	151.0								

AMMONIA NITROGEN CONCENTRATION CHART

%T	RANGE	POUNDS PER ACRE
58-100%	Low	0-24 lbs/acre
29-57%	Medium	25-68 lbs/acre
0-28%	High	Over 71 lbs/acre

CALCIUM & MAGNESIUM TEST

SCHWARZENBACH EDTA METHOD

QUANTITY	CONTENTS	CODE
30 mL	*Calcium & Magnesium Buffer	*5126-G
60 mL	Standard EDTA Reagent	5254-H
100	Calcium Hardness Indicator Tablets	T-5250-J
30 mL	Calcium Magnesium Inhibitor Reagent	3922-G
30 mL	*CM Indicator Reagent	*6522WT-G
30 mL	*Sodium Hydroxide w/Metal Inhibitors	*4259-G
15 mL	*Inhibitor Solution	*9258-E
15 mL	*TEA Reagent	*3921-E
2	Direct Reading Titrators, 0-1000 Range	0384
1	Pipet, transfer, plastic	0364
1	Test tube, 5-10-15 mL, glass, w/cap	0778

***WARNING:** Reagents marked with a * are considered hazardous substances. Material Safety Data Sheets (MSDS) are supplied for these reagents. For your safety read label and MSDS before using.

The amount of total calcium in soils may range from as little as 0.1% to as much 25%. A calcium deficiency is rarely a problem due to widely accepted practice of applying lime to soil to raise the pH to the proper range for optimum plant growth. As an important mineral nutrient, calcium is a component of cell walls in plants and is known to stimulate root and leaf development as well as activate several enzyme reactions involved in plant metabolism. Indirectly, calcium influences crop yields by reducing soils acidity and by reducing the toxicity of several other soil minerals such as manganese, zinc, and aluminum.

The Schwarzenbach EDTA titration method, used to determine calcium and magnesium, involves two titrations. The first titration gives the calcium and magnesium content, the second only calcium. Magnesium is calculated from the difference between the titration values.

Carefully read the LaMotte Direct Reading Titrator Manual before performing the titrations described below.

RANGE:	Calcium	0-400 lbs/A
	Magnesium	0-240 lbs/A
METHOD:	Titration with Schwarzenbach EDTA	
INTERFERENCE:	Sample color and turbidity may interfere with endpoint.	

DILUTION OF SOIL EXTRACT

Use the 30 mL graduated cylinder (0418) to measure 10 mL of the soil extract and transfer it to a 50 mL beaker (0944). Add 10 mL of deionized water, mix and neutralize according to the procedure on page 10.

TITRATION A, CALCIUM & MAGNESIUM

1. Fill the test tube (0778) to the 5 mL line with the soil extract from above. Dilute to the 10 mL line with deionized water.
2. Add 5 drops of Calcium Magnesium Inhibitor Reagent (3922).
3. Wait 5 minutes.
4. Use a transfer pipet (0364) to add 5 drops of *Calcium & Magnesium Buffer (5126).
5. Add 10 drops of *CM Indicator (6522WT).
6. Fill the Direct Reading Titrator (0384) with the Standard EDTA Reagent (5254). Insert the tip of the Titrator into the center hole of the test tube cap.
7. While gently swirling the tube, slowly press the plunger to titrate until the color changes from red to blue.
8. Read the Titrator scale at the tip of the plunger and multiply by 5.16. This is Titration Value A.

TITRATION B, CALCIUM

1. Fill the test tube (0778) to the 5 mL line with the diluted soil extract. Dilute to 10 mL with deionized water.
2. Add 2 drops of *Inhibitor Solution (9258).
3. Add 2 drops of *TEA Reagent (3921).
4. Add 8 drops of *Sodium Hydroxide w/Metal Inhibitors (4259).
5. Add one Calcium-Hardness Indicator Tablet (T-5250) to the test sample. Cap and shake to dissolve the tablet. A red color will develop.
6. Immediately titrate the sample. Fill the Direct Reading Titrator with Standard EDTA Reagent (5254). Insert the tip of the Titrator into the hole in the cap of the test tube.
7. While gently shaking the tube, slowly press the plunger to titrate until the red color changes to a clear blue and does not revert to red upon standing 1 - 2 minutes.
8. Read the Titrator scale at the tip of the plunger and multiply by 5.16. This is Titration Value B.

FINAL RESULTS

Calcium Content = $0.4 \times \text{Titration Value B} = \text{ppm Ca}$

Magnesium Content = $0.24 (\text{Value A} - \text{Value B}) = \text{ppm Mg}$

Multiply the results by 2 to obtain the content in pounds per acre.

EXAMPLE:

Titration Value A is 640 ppm CaCO_3

Titration Value B is 520 ppm CaCO_3

Calcium	= $0.4 \times 520 = 208 \text{ ppm Ca}$
	= $208 \times 2 = 416 \text{ lb/acre Ca}$
Magnesium	= $0.24 (640-520)$
	= $0.24 \times 120 = 29 \text{ ppm Mg}$
	= $29 \times 2 = 58 \text{ lb/acre Mg}$

CHLORIDE TEST DIRECT READING TITRATOR METHOD

QUANTITY	CONTENTS	CODE
15 mL	*Chloride Reagent #1	*4504-E
60 mL	*Silver Nitrate, 0.141N	*3062DR-H
1	Extracting Tube, plastic, w/cap	0989
1	Spoon, 1g	0697
1	Test Tube, 5-10-15 mL, glass, w/cap	0778
1	Direct Reading Titrator, 0-1000 Range	0384

***WARNING:** Reagents marked with a * are considered hazardous substances. Material Safety Data Sheets (MSDS) are supplied for these reagents. For your safety, read label and accompanying MSDS before using.

Chlorides are present in practically all soils. Application of fertilizer may increase chloride levels. Chlorides are removed from soil by leaching. Excessive concentrations are toxic to plants. A high test reading, particularly where stunted growth has been observed, may indicate poisoning due to high chloride levels in the soil.

RANGE: 0-1000 lbs/A

METHOD: In a neutral or slightly alkaline solution, potassium dichromate indicates the endpoint of the silver nitrate titration.

INTERFERENCES: Bromine, Iodide, and Cyanide register as equivalent chloride concentrations.

Carefully read the LaMotte Direct Reading Titrator Manual before performing the titration procedure described below. The Titrator is calibrated in terms of parts per million chloride and each minor division on the Titrator scale equals 20 ppm.

PROCEDURE

1. Fill a clean extracting tube (0989) to the mark with deionized water.
2. Add 3 one gram measures of soil using the 1 g spoon (0697). Cap tube and shake for five minutes.
3. Filter and collect all of the soil filtrate using the funnel (0459) and filter paper (0463). The filtrate does not have to be clear since a slight turbidity does not interfere in the test.
4. Fill the test tube (0778) to the 10 mL line with the filtrate.
5. Add three drops of *Chloride Reagent #1 (4504) to the sample. Cap and shake to mix. A yellow color will result.
6. Fill the Direct Reading Titrator (0384) with *Silver Nitrate, 0.141 (3062DR) in the manner described in the instruction manual.
7. Titrate the test sample with *Silver Nitrate, 0.141 (3062DR) until the yellow color changes permanently to pink. Record the Titrator reading. If the plunger reaches the bottom mark (1000 ppm) on the Titrator scale before the endpoint color change occurs, refill the Titrator and continue the titration procedure. Be sure to include the value of the original amount added (1000 ppm) when recording the final result.

This test is valuable on saline soils or when contamination from sea water or sea spray is suspected. Normal soils of humid regions rarely give readable tests, except when recently receiving liberal amounts of fertilizers containing chlorides.

COPPER TEST

DIETHYLDITHIOCARBAMATE METHOD

QUANTITY	CONTENTS	CODE
15 mL	*Copper Reagent	*6446-E

***WARNING:** Reagents marked with a * are considered hazardous substances. Material Safety Data Sheets (MSDS) are supplied for these reagents. For your safety, read label and accompanying MSDS before using.

Like many other micronutrients, the amount of available copper varies considerably with the type of soil. Well drained sandy soils are usually low in copper while heavily clay-type soils contain an abundant supply of copper. Like manganese, copper may be unavailable in soils that have a high organic make-up because it readily forms insoluble complexes with organic compounds.

Generally from 0.2-25 lbs/A of copper is added to the soil to correct a deficient level. Copper is another metal that is necessary in the formation of the chlorophyll molecule and like other metals, e.g. iron, manganese and zinc acts as a catalyst.

RANGE: 0-25 ppm

METHOD: Cupric ions form a yellow colored chelate with Diethyldithiocarbamate around pH 9-10, in proportion to the concentration of copper in the sample.

INTERFERENCES: Bismuth, cobalt, mercury, nickel and silver ions and chlorine (6 ppm or greater) interfere seriously and must be absent.

PROCEDURE

1. Fill a clean colorimeter tube (0967) to the 10 mL line with the soil filtrate then neutralize according to the procedure on page 10.
2. Select setting 2 on the "Select Wavelength" knob.
3. Insert tube containing sample into chamber and press the "30 Second Read" button. Adjust "100"%T with the "Set Blank" knob.
4. Remove the tube and add 5 drops of *Copper Reagent (6446). Cap and mix contents. A yellow color indicates the presence of copper.
5. Insert sample into colorimeter chamber, press the "30 Second Read" button and measure %T as soon as reading stabilizes.
6. Consult chart to find the concentration of Copper in parts per million.

NOTE: There is a tendency for the meter to drift with the use of the blue filter (415nm) as a result of the photocell's response to blue light. For best results, after sample has been inserted into chamber and covered, allow approximately 10 seconds before taking the reading.

COPPER CALIBRATION CHART (PPM)

%T	9	8	7	6	5	4	3	2	1	0
90	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
80	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9
70	2.0	2.2	2.3	2.4	2.5	2.6	2.8	2.9	3.0	3.1
60	3.3	3.4	3.5	3.7	3.8	3.9	4.1	4.2	4.4	4.5
50	4.7	4.8	5.0	5.2	5.3	5.5	5.6	5.8	6.0	6.2
40	6.4	6.5	6.7	6.9	7.1	7.3	7.5	7.7	8.0	8.2
30	8.4	8.6	8.9	9.1	9.4	9.6	9.9	10.2	10.5	10.8
20	11.1	11.4	11.7	12.1	12.4	12.8	13.2	13.6	14.0	14.4
10	14.9	15.4	15.9	16.4	17.0	17.6	18.3	19.0	19.8	20.7
0	21.6	22.7	23.9	25.3						

COPPER CONCENTRATION CHART

%T	RANGE	PARTS PER MILLION
89-100%	Low	0-1 ppm
71-88%	Marginal	1-3 ppm
63-70%	Adequate	3-4 ppm

IRON TEST - BIPYRIDYL METHOD

QUANTITY	CONTENTS	CODE
30 mL	*Iron Reagent #1	*V-4450-G
5 g	*Iron Reagent #2 Powder	*V-4451-C
1	Pipet, 0.5 mL	0353
1	Spoon, 0.1 g	0699

***WARNING:** Reagents marked with a * are considered hazardous substances. Material Safety Data Sheets (MSDS) are supplied for these reagents. For your safety, read label and accompanying MSDS before using.

Iron is essential to the formation of chlorophyll, and iron deficiency causes chlorosis. While most soils contain abundant iron, only a fraction is soluble and readily available to the growing plant. This is particularly true in neutral or alkaline soils. Acid soils contain higher levels of available iron.

RANGE: 0-25 ppm

METHOD: Ferric iron is reduced to ferrous iron and subsequently forms a colored complex with bipyridyl for a quantitative measure of total iron.

INTERFERENCES: Strong oxidizing agents interfere, as well as copper and cobalt in excess of 5.0 mg/L

PROCEDURE

1. Fill a clean colorimeter tube (0967) to the 10 mL line with the soil filtrate then neutralize according to the procedure on page 10.
2. Select setting 3 on the "Select Wavelength" knob. Press the "30 Second Read" button.
3. Insert tube containing sample into chamber and adjust to "100"%T with the "Set Blank" knob. This is the 100%T blank.
4. Remove the tube from the chamber. With 0.5 mL pipet (0353) add one measure of *Iron Reagent #1 (4450) to sample. Cap and mix.
5. With the 0.1 g spoon (0699) add one level measure of *Iron Reagent #2 Powder (4451) to sample. Cap and shake vigorously for 30 seconds.
6. Allow three minutes for maximum color development.
7. After three minutes, insert sample into colorimeter chamber, press the "30 Second Read" button and measure %T as soon as reading stabilizes.
8. Consult the calibration chart to find the concentration of Iron in parts per million (ppm).

IRON CALIBRATION CHART (PPM)

%T	9	8	7	6	5	4	3	2	1	0
90	0.1	0.2	0.3	0.4	0.4	0.5	0.6	0.7	0.8	0.9
80	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	2.0
70	2.1	2.2	2.3	2.4	2.5	2.6	2.8	2.9	3.0	3.1
60	3.3	3.4	3.5	3.7	3.8	3.9	4.1	4.2	4.4	4.5
50	4.6	4.8	5.0	5.1	5.3	5.4	5.6	5.8	6.0	6.1
40	6.3	6.5	6.7	6.9	7.1	7.3	7.5	7.7	7.9	8.1
30	8.4	8.6	8.9	9.1	9.4	9.6	9.9	10.2	10.5	10.8
20	11.1	11.4	11.8	12.1	12.5	12.9	13.3	13.7	14.1	14.6
10	15.0	15.6	16.1	16.7	17.3	17.9	18.7	19.4	20.3	21.2
0	22.2	23.4	24.7	26.2	28.0	30.3	33.2	37.4	44.7	

IRON CONCENTRATION CHART

%T	RANGE	PARTS PER MILLION
86-100%	Very Low	0-1.3 ppm
70-85%	Low	1.4-3 ppm
57-69%	Medium	3-5 ppm
32-56%	Medium High	5-10 ppm
0-31%	High	Above 10-25 ppm

MANGANESE TEST - PERIODATE METHOD

QUANTITY	CONTENTS	CODE
10 g	Manganese Buffer Reagent	6310-D
15 g	*Manganese Periodate Reagent	*6311-E
2	Spoon, 0.1 g	0699

The amount of manganese available to the plant is dependant upon the soil pH, the quantity of organic matter present, and the degree of aeration. Manganese deficiency is most likely to occur in neutral or alkaline soils because it is less soluble at elevated pH levels. In extremely acid soils, where manganese is more soluble, toxic levels may exist which may reduce crop yields. In slightly acid sandy soils, manganese may leach past the root zone and not be able for utilization by the plant. Also, it is believed that manganese may form insoluble organic complexes in some soils that have high humus content. All of the factors contribute to the availability of this essential element. Only soil or tissue tests can determine whether deficient or toxic levels of manganese exist.

Although manganese is known to play an important role in many of the metabolic processes in the plant, little is known about its function other than it is required in some enzyme reactions and is required for the formation of chlorophyll in the plant.

RANGE: 0-100 ppm

METHOD: Periodate method.

INTERFERENCES: Reducing substances capable of reacting with periodate or permanganate must be eliminated. Chlorine in small amounts can be oxidized by periodate.

PROCEDURE

1. Fill a clean colorimeter tube (0967) to the 10 mL line with the soil filtrate then neutralize according to the procedure on page 10.
2. Select setting 4 on the "Select Wavelength" knob.
3. Insert tube containing sample into chamber and press the "30 Second Read" button. Adjust to "100"%T with the "Set Blank" knob.
4. Remove the tube and add two level measures of Manganese Buffer Reagent (6310) with the 0.1 g spoon (0699). Cap and mix to dissolve the powder.
5. With the other 0.1 g spoon (0699), add one heaping measure of *Manganese Periodate Reagent (6311) to the contents of the tube, cap and mix. An undissolved portion of the reagents may remain in the bottom of the tube without adversely affecting the results.
6. Allow approximately two minutes for the pink color to develop if manganese is present.
7. Insert test sample into colorimeter chamber, press the "30 Second Read" button, and measure %T as soon as reading stabilizes.
8. Consult chart to find the concentration of Manganese in parts per million (ppm).

MANGANESE CALIBRATION CHART (PPM)

%T	9	8	7	6	5	4	3	2	1	0
90		0.0	0.4	0.8	1.2	1.6	2.0	2.4	2.8	3.2
80	3.6	4.0	4.5	4.9	5.3	5.8	6.2	6.7	7.1	7.6
70	8.0	8.5	9.0	9.5	9.9	10.4	10.9	11.4	12.0	12.5
60	13.0	13.5	14.1	14.6	15.2	15.7	16.3	16.9	17.5	18.1
50	18.7	19.3	19.9	20.6	21.2	21.9	22.6	23.2	23.9	24.6
40	25.4	26.1	26.8	27.6	28.4	29.2	30.0	30.8	31.7	32.5
30	33.4	34.3	35.3	36.2	37.2	38.2	39.2	40.3	41.4	42.5
20	43.7	44.9	46.1	47.4	48.7	50.1	51.5	53.0	54.6	56.2
10	57.9	59.7	61.6	63.6	65.7	67.9	70.3	72.8	75.6	78.6
0	81.9	85.5	89.6	94.3	99.7					

MANGANESE CONCENTRATION CHART

%T	RANGE	PARTS PER MILLION
86-100%	Low	0-5 ppm
71-85%	Medium	5-12 ppm
51-70%	Medium High	13-24 ppm
32-50%	High	25-40 ppm
0-31%	Very High	Over 40 ppm

NITRATE NITROGEN TEST CADMIUM REDUCTION METHOD

QUANTITY	CONTENTS	CODE
2 x 60 mL	*Mixed Acid Reagent	*V-6278-H
5 g	*Nitrate Reducing Reagent	*V-6279-C
1	Spoon, 0.1g	0699

***WARNING:** Reagents marked with a * are considered hazardous substances. Material Safety Data Sheets (MSDS) are supplied for these reagents. For your safety, read label and accompanying MSDS before using.

Nitrogen is a component of the chlorophyll (green color) in plants, thus giving plants the rich green color characteristic of a healthy plant. Nitrogen promotes succulence in forage crops and leafy vegetables. When used at the recommended rates, nitrogen improves the quality of leaf crops. It also simulates the utilization of phosphorus, potassium and other essential nutrient elements. The above-ground growth of plants is enhanced with nitrogen. Nitrogen hastens crop maturity (assuming all other nutrients are adequately supplied and excessive nitrogen rates are not applied). Nitrogen is very influential in fruit sizing.

RANGE: 0-150 lbs/A

METHOD: Powdered cadmium is used to reduce nitrate to nitrite. The nitrite that is originally present plus reduced nitrate is determined by diazotizing sulfanilamide and coupling with N-(1 naphthyl)-ethylenediamine dihydrochloride to form a highly colored azo dye which is measured colorimetrically.

INTERFERENCES: Strong oxidizing and reducing substances interfere. Low results might be obtained for samples that contain high concentrations of iron and copper.

PROCEDURE

1. Select setting 4 on the "Select Wavelength" knob.
2. Use the 1 mL pipet (0354) to add 1 mL of soil filtrate to a clean colorimeter tube (0967) and dilute to the line with deionized water. Cap tube and mix.
3. Measure 5 mL of the diluted soil filtrate to another colorimeter tube (0967), then add 5 mL of *Mixed Acid Reagent (6278). Use the 10 mL graduated cylinder (0416) for these measurements. Cap the tube and mix, then insert tube into colorimeter chamber and press the "30 Second Read" button. Adjust "100"%T with the "Set Blank" knob.
4. Remove the tube from the chamber. Use the 0.1 g spoon (0699) to add two level measures of *Nitrate Reducing Reagent (6279) to the contents of tube and cap.
5. Hold tube by index finger and thumb and mix by inverting approximately 50-60 times in a minute, then let stand 10 minutes for maximum color development. (**NOTE:** At the end of the waiting period an undissolved portion of the *Nitrate Reducing Reagent may remain in the bottom of the tube without affecting the results.)
6. At the end of the 10 minute waiting period, insert tube into chamber of colorimeter, press the "30 Second Read" button and measure %T as soon as reading stabilizes.
7. Consult chart to find the concentration of Nitrate Nitrogen, in the soil, in pounds per acre.

NITRATE NITROGEN CALIBRATION CHART (lbs/acre)

%T	9	8	7	6	5	4	3	2	1	0
90	2	3	5	6	7	8	10	11	12	14
80	15	16	18	19	20	22	23	25	26	27
70	29	30	32	34	35	37	38	40	42	43
60	45	47	48	50	52	54	56	58	60	62
50	64	66	68	70	72	74	76	78	81	83
40	86	88	90	93	96	98	101	104	107	110
30	113	116	119	122	125	129	132	136	140	144
20	148	152								

NITRATE NITROGEN CONCENTRATION CHART

%T	RANGE	POUNDS PER ACRE
93-100%	Low	0-9.0 lbs/acre
79-92%	Medium	11-29 lbs/acre
65-78%	Medium High	33-51 lbs/acre
43-64%	High	53-100 lbs/acre
0-42%	Very High	Over 100 lbs/acre

NITRITE NITROGEN TEST DIAZOTIZATION METHOD

QUANTITY	CONTENTS	CODE
2 x 60 mL	*Mixed Acid Reagent	*V-6278-H
5 g	*Color Developing Reagent	*V-6281-C
1	Spoon, 0.1g	0699

***WARNING:** Reagents marked with a * are considered hazardous substances. Material Safety Data Sheets (MSDS) are supplied for these reagents. For your safety, read label and accompanying MSDS before using.

Nitrites are formed as an intermediate step in the production of nitrate. Soils that are well drained and aerated contain only small amounts of nitrite nitrogen. Excessive nitrites, which are toxic to plants, may result from soil conditions unfavorable to the formation of nitrate, such as inadequate aeration. High nitrite readings may also be encountered in soils with large amounts of nitrates, where a portion of the nitrate nitrogen decomposes to form nitrites.

RANGE: 0-53 lbs/A

METHOD: The diazonium compound formed by diazotization of sulfanilamide by nitrite in water under acid conditions is coupled with N-(1-naphthyl)-ethylenediamine to produce a reddish-purple color which is read colorimetrically.

INTERFERENCES: There are few known interferences of substances at concentrations less than 1000 times that of nitrite; however, the presence of strong oxidants or reductants may readily affect the nitrite concentrations. High alkalinity (above 600 mg/L) will give low results due to a shift in pH.

PROCEDURE

1. Use the 1 mL pipet (0354) to add 2 mL of soil filtrate to a clean colorimeter tube (0967) and dilute to the line with deionized water. Cap tube and mix.
2. Select setting 4 on the "Select Wavelength" knob.
3. Measure 5 mL of diluted soil filtrate into another colorimeter tube, then add 5 mL of *Mixed Acid Reagent (6278). Use the small graduated cylinder (0416) for these measurements. Cap the tube and mix, then insert the tube into colorimeter chamber and press the "30 Second Read" button. Adjust "100"%T with the "Set Blank" knob.
4. Remove the tube from the chamber. Using the 0.1 g spoon (0699), add two level measures of *Color Developing Reagent (6281) to the contents of tube and cap.
5. Shake tube for approximately one minute to dissolve the powder, then let stand for 5 minutes for maximum color development.
6. At the end of the 5 minute waiting period, insert tube into chamber, press the "30 Second Read" button and measure %T as soon as reading stabilizes.
7. Consult chart to find the nitrite nitrogen concentration in pounds per acre.

NITRITE NITROGEN CALIBRATION CHART (LBS/A)

%T	9	8	7	6	5	4	3	2	1	0
100								0.0	0.1	0.2
90	0.3	0.5	0.6	0.7	0.8	1.0	1.1	1.2	1.3	1.5
80	1.6	1.7	1.9	2.0	2.1	2.3	2.4	2.6	2.7	2.8
70	3.0	3.1	3.3	3.4	3.6	3.7	3.9	4.1	4.2	4.4
60	4.5	4.7	4.9	5.0	5.2	5.4	5.6	5.8	5.9	6.1
50	6.3	6.5	6.7	6.9	7.1	7.3	7.5	7.7	7.9	8.2
40	8.4	8.6	8.8	9.1	9.3	9.6	9.8	10.1	10.3	10.6
30	10.9	11.2	11.4	11.7	12.0	12.4	12.7	13.0	13.4	13.7
20	14.1	14.4	14.8	15.2	15.6	16.1	16.5	17.0	17.5	18.0
10	18.5	19.1	19.7	20.4	21.0	21.8	22.6	23.4	24.3	25.3
0	26.5	27.7	29.2	30.9	32.9	35.5	38.8	43.8	53.0	

NITRITE NITROGEN CONCENTRATION CHART

%T	RANGE	POUNDS PER ACRE
86-100%	Low	0-2 lbs/acre
73-85%	Medium	2.5-4 lbs/acre
42-72%	High	4.5-10 lbs/acre
0-41%	Very High	Over 10 lbs/acre

PHOSPHORUS TEST

ASCORBIC ACID REDUCTION METHOD

QUANTITY	CONTENTS	CODE
60 mL	*Phosphate Acid Reagent	*V-6282-H
5 g	*Phosphate Reducing Reagent	*V-6283-C
1	Pipet, 1 mL, plastic	0354
1	Spoon, 0.1 g	0699

***WARNING:** Reagents marked with a * are considered hazardous substances. Material Safety Data Sheets (MSDS) are supplied for these reagents. For your safety read label and accompanying MSDS before using.

Phosphorus is necessary for the hardy growth of the plant and activity of the cells. It encourages root development, and by hastening the maturity of the plant, it increases the ratio of grain to straw, as well as the total yield. It plays an important part in increasing the palatability of plants and simulates the formation of fats, convertible starches and healthy seed. By stimulating rapid cell development in the plant, phosphorus naturally increases the resistance to disease. An excess of phosphorus does not cause the harmful effect of excessive nitrogen and has an important balancing effect upon the plant.

RANGE: 0-99 lbs/A

METHOD: Ammonium molybdate and antimony potassium tartrate react in a filtered acid medium with dilute solution of PO₄-2 to form an antimony-phosphomolybdate complex. This complex is reduced to an intense blue colored complex by ascorbic acid. The color is proportionate to the amount of phosphate present. (Only orthophosphate forms a blue color in this test.) Polyphosphates (and some organic phosphorus compounds) may be converted to the orthophosphate form by sulfuric acid digestion. Organic phosphorus compounds may be converted to the orthophosphate form by persulfate digestion.

INTERFERENCES: High iron concentrations can cause precipitation of and subsequent loss of phosphorus.

PROCEDURE

- Use the 1 mL pipet (0354) to add 1 mL of the soil filtrate to a clean colorimeter tube (0967) and dilute to the 10 mL line with deionized water.
- Select setting 4 on the "Select Wavelength" knob.
- Insert the tube containing the diluted soil filtrate into chamber and press the "30 Second Read" button. Adjust "100"%T with the "Set Blank" knob.
- Remove the tube containing the diluted soil filtrate and add one measure of *Phosphate Acid Reagent (6282) with the 1 mL pipet (0354), cap tube and mix.
- With the 0.1 g spoon (0699), add one level measure of *Phosphate Reducing Reagent (6283) and shake until dissolved. Allow five minutes for full color development. Phosphates exhibit a clear blue color.
- At the end of the waiting period, insert test sample into colorimeter chamber, press the "30 Second Read" button and measure %T as soon as reading stabilizes.
- Consult the chart to find the concentration of Phosphorus (P), in the soil, in pounds per acre.

PHOSPHORUS CALIBRATION CHART (LBS/A)

%T	9	8	7	6	5	4	3	2	1	0
90	0.2	1.0	1.7	2.4	3.1	3.9	4.6	5.4	6.2	6.9
80	7.7	8.5	9.3	10.1	10.9	11.8	12.6	13.5	14.3	15.2
70	16.1	17.0	17.9	18.8	19.7	20.7	21.6	22.6	23.6	24.6
60	25.6	26.7	27.7	28.8	29.9	31.0	32.1	33.2	34.4	35.6
50	36.8	38.0	39.3	40.5	41.8	43.2	44.5	45.9	47.3	48.8
40	50.2	51.8	53.3	54.9	56.5	58.2	59.9	61.7	63.5	65.4
30	67.3	69.3	71.3	73.4	75.6	77.9	80.2	82.6	85.1	87.8
20	90.5	93.3	96.3	99.4						

PHOSPHORUS CONCENTRATION CHART

%T	RANGE	POUNDS PER ACRE
81-100%	Very Low	0-14 lbs/acre
61-80%	Low	16-34 lbs/acre
39-60%	Medium	35-67 lbs/acre
0-38%	High	Over 70 lbs/acre

PHOSPHORUS IN ALKALINE SOILS

A special extraction procedure is used for determining the available phosphorus content of Western U.S. alkaline soils where the pH value is above 7.0.

EXTRACTION PROCEDURE

1. Use the 1 mL pipet (0354) to add 1 mL of the *Special NF Extracting Solution (6362) to the graduated vial (0989) then add deionized water to the graduation.
2. Add 3 one gram measures of soil using the 1 g spoon (0697) to the extracting solution in the vial.
3. Cap the vial and shake for a period of 5 minutes.
4. Filter using the funnel (0459) and filter paper (0463). Collect all of the filtrate.
5. Perform the Phosphorus test according to the Phosphorus procedure given above.

POTASSIUM TEST TETRAPHENYLBORON METHOD

QUANTITY	CONTENTS	CODE
30 mL	*Sodium Hydroxide, 0.1N	*4004WT-G
5g	*Tetraphenylboron Powder	*6364-C
1	Pipet, 1 mL	0354
1	Spoon, 0.05g	0696

***WARNING:** Reagents marked with a * are considered hazardous substances. Material Safety Data Sheets (MSDS) are supplied for these reagents. For your safety, read label and accompanying MSDS before using.

Potassium is not a component of the structural makeup of plants, yet it plays a vital role in the physiological and biochemical functions of plants. The exact function of potassium in plants is not clearly understood, but many beneficial factors, implicating the involvement and necessity of potassium in plant nutrition have been demonstrated. Some of these factors are: it enhances disease resistance by strengthening stalks and stems; activates various enzyme systems within plants; contributes to a thicker cuticle (waxy layer) which guards against disease and water loss; controls the turgor pressure within plants to prevent wilting; enhances fruit size, flavor, texture and development and is involved in the production of amino acids (the building blocks for protein), chlorophyll formation (green-color), starch formation and sugar transport from leaves to roots.

When present in large amounts, ammonia salts will produce a precipitate similar to that produced by potassium. If fertilizer containing ammonia salts has recently been applied, or if the soil pH is below pH 5.0, perform the ammonia test before performing the potassium test. A high ammonia nitrogen test result will alert the operator to a probable false high reading in the potassium test; actual potassium tests will be somewhat lower.

RANGE: 0-500 lbs/A

METHOD: Potassium reacts with sodium tetraphenylboron to form a colloidal white precipitate in quantities proportional to the potassium concentration measured as turbidity.

INTERFERENCES: Calcium and Magnesium at very high concentrations.

PROCEDURE

- Use the 1 mL pipet (0354) to add 2 ml of the soil filtrate to a clean colorimeter tube (0967) and dilute to the 10 mL line with deionized water.
- Select setting 1 on the "Select Wavelength" knob.
- Insert the tube containing the diluted soil filtrate into chamber and press the "30 Second Read" button. Adjust "100"%T with the "Set Blank" knob.
- Remove the tube containing the diluted soil filtrate and add 4 drops of *Sodium Hydroxide, 1.0 N (4004) and mix.
- With the 0.05 g spoon (0696), add 1 level measure of *Tetraphenylboron Powder (6364). Cap the tube and shake vigorously until all of the powder has dissolved.
- After standing 5 minutes, shake the tube to suspend any settled precipitate and immediately place it in the colorimeter chamber, press the "30 Second Read" button and measure the %T as soon as the reading stabilizes.
- Consult the chart to find the concentration in pounds per acre of Potassium in the soil.

POTASSIUM CALIBRATION CHART (LBS/A)

%T	9	8	7	6	5	4	3	2	1	0
90	22.9	26.5	30.1	33.6	37.1	40.5	43.9	47.3	50.5	53.8
80	57.0	60.1	63.2	66.2	69.2	72.1	75.0	77.8	80.6	83.3
70	86.0	88.6	91.2	93.7	96.2	98.6	100.9	103.2	105.5	107.7
60	109.8	111.9	114.0	116.0	118.0	119.9	121.7	123.6	125.4	127.1
50	128.8	130.5	132.1	133.7	135.3	136.8	138.4	139.9	141.4	142.9
40	144.3	145.8	147.3	148.9	150.4	152.0	153.7	155.3	157.1	159.0
30	160.9	163.0	165.2	167.5	170.1	172.8	175.8	179.1	182.7	186.6
20	191.0	195.8	201.1	207.0	213.5	220.9	229.1	238.2	248.6	260.2
10	273.2	288.0	304.7	323.7	345.4	370.1	398.3	430.8	468.3	511.6

POTASSIUM CONCENTRATION CHART

%T	RANGE	POUNDS PER ACRE
93-100%	Very Low	0-44 lbs/acre
82-91%	Low	50-76 lbs/acre
50-81%	Medium	82-143 lbs/acre
18-80%	High	144-281 lbs/acre
0-17%	Very High	Over 294 lbs/acre

SULFUR TEST

BARIUM CHLORIDE METHOD

QUANTITY	CONTENTS	CODE
60 mL	*Sulfate Extracting Solution	*6363-H
10 g	*Sulfate Reagent	*V-6277-D
1	Pipet, 1 mL, plastic	0354
1	Spoon, 1.0g	0697
1	Spoon, 0.1 g	0699

***WARNING:** Reagents marked with a * are considered hazardous substances. Material Safety Data Sheets (MSDS) are supplied for these reagents. For your safety, read label and accompanying MSDS before using.

Sulfur is essential to the formation of protein and affects various aspects of plant metabolism. Sulfur-deficient plants are pale green in color with thin, reedy stems. Negatively charged sulfate ions are easily leached. The major sources of soil sulfate are fertilizer containing sulfate compounds and atmospheric sulfur dioxide carried into the soil by precipitation.

RANGE: 0-172 ppm

METHOD: Sulfate ion is precipitated in an acid medium with barium chloride to form barium sulfate crystals in proportion to the amount of sulfate present.

INTERFERENCE: Suspended matter and color interference may be removed by a filtration step. Silica in excess of 500 mg/L will interfere.

PROCEDURE

- Use the 1 mL pipet (0354) to add 1 mL of *Sulfate Extracting Solution (6363) to the graduated vial (0989) then add deionized water to the graduation.
- Add 3 one gram measures of soil using the 1 g spoon (0697). Cap vial and shake for five minutes.
- Filter and collect all of the soil filtrate using the funnel (0459) and filter paper (0463). If the filtrate is not clear, filter a second time.
- Fill a clean colorimeter tube (0967) to the 10 mL line with the soil filtrate.
- Select setting 1 on the "Select Wavelength" knob.
- Insert tube containing sample into chamber and press the "30 Second Read" button. Adjust "100"%T with the "Set Blank" knob.
- Remove the tube from the chamber. Use the 0.1 g spoon (0699) to add one level measure of *Sulfate Reagent (6277) to the sample tube. Cap the tube and shake until powder has dissolved. A white precipitate will develop if sulfates are present.
- Allow the reaction to proceed for 5 minutes, then mix again before inserting tube into chamber of colorimeter. Cover and measure %T as soon as reading stabilizes.
- Consult chart to find the concentration in parts per million (ppm) of sulfur.

NOTE: A white film is deposited on the inside of test tubes as a result of the sulfate test. Thoroughly clean and rinse test tubes after each test.

SULFUR CALIBRATION CHART (ppm)

%T	9	8	7	6	5	4	3	2	1	0
90	6.7	7.2	7.6	8.1	8.5	9.0	9.4	9.9	10.3	10.8
80	11.2	11.7	12.2	12.6	13.1	13.6	14.0	14.5	15.0	15.5
70	16.0	16.5	17.0	17.5	18.0	18.5	19.1	19.6	20.1	20.7
60	21.2	21.8	22.3	22.9	23.5	24.1	24.6	25.3	25.9	26.5
50	27.1	27.8	28.5	29.1	29.8	30.5	31.3	32.0	32.8	33.5
40	34.4	35.2	36.0	36.9	37.8	38.8	39.7	40.7	41.8	42.9
30	44.0	45.2	46.4	47.7	49.1	50.5	52.0	53.6	55.2	57.0
20	58.9	60.9	63.0	65.3	67.8	70.4	73.3	76.4	79.8	83.5
10	87.6	92.0	97.0	102.6	108.8	115.9	124.0	133.3	144.1	156.9
0	172.1									

SULFUR CONCENTRATION CHART

%T	RANGE	PARTS PER MILLION
79-100%	Low	0-16 ppm
55-78%	Medium Low	17-30 ppm
34-54%	Medium	31-50 ppm
0-33%	High	52-75 ppm

ZINC TEST ZINCON METHOD

QUANTITY	CONTENTS	CODE
30 mL	*Zinc Indicator Solution	*6314-G
120 mL	*Methyl Alcohol	*6319-J
10 g	Sodium Ascorbate	6316-D
25 g	*Zinc Buffer Powder	*6315-G
15 mL	*Sodium Cyanide, 10%	*6565-E
30 mL	*Formaldehyde Solution, 37%	*5128-G
1	“Diluted Zinc Indicator Solution”, Bottle, w/1 mL pipet assembly	0128-MT
1	Graduate Cylinder, 10 mL, glass	0416
1	Spoon, 0.5 g	0698
2	Pipets, dropping, plastic	0352
1	Spoon, 0.1 g	0699

***WARNING:** Reagents marked with a * are considered hazardous substances. Material Safety Data Sheets (MSDS) are supplied for these reagents. For your safety read label and accompanying MSDS before using.

The availability of zinc in soils decreases with an increase in soil pH. Some soils that are limited above pH 6.0 may show a zinc deficiency especially in well drained sandy soils. A nutrient interaction exists between soils that have a high phosphorous level and show a zinc deficiency even though zinc levels were sufficient. This interaction is due to the preferential uptake of phosphorus instead of zinc and the possible formation of insoluble zinc phosphates. Once zinc is applied to the soil, it is relatively immobile because it is readily absorbed by organic matter in the soil.

Zinc is essential in promoting certain enzyme reactions in the soil and is required for the production of chlorophyll and the formation of carbohydrates in plants.

APPLICATION: Drinking and surface waters, domestic and industrial waste water.

RANGE: 0.01 - 3.0 ppm

METHOD: Zinc forms a blue colored complex with Zincon in a solution buffered at pH 9.0. Other heavy metals are complexed by cyanide and the zinc cyanide complex is released by the addition of formaldehyde before the other metal cyanide complexes are destroyed. Sodium ascorbate is added to reduce the interference of manganese.

SAMPLE HANDLING & PRESERVATION: Sample should be analyzed within 6 hours after collection. The addition of HCl will help preserve the metal ion content, however the acid should be neutralized before analysis.

INTERFERENCES: The following ions interfere in concentrations greater than those listed.

ION	MG/L	ION	MG/L
Cd(II)	1	Cr(III)	10
Al (III)	5	Ni(II)	20
Mn (II)	5	Cn (II)	30
Fe (III)	7	Co (II)	30
Fe (II)	9	CrO4(II)	50

PROCEDURE

A. PREPARATION OF DILUTED ZINC INDICATOR SOLUTION

1. Use one pipet (0352) to measure exactly 5.0 mL of Zinc Indicator Solution into the 10 mL graduate cylinder. The bottom of the curved surface (the meniscus) of the liquid should be at the 5.0 mL mark. Pour this into the bottle labeled "Diluted Zinc Indicator Solution".
2. Use the unrinsed graduated cylinder first to add 10.0 mL and then 7.8 mL (total of 17.8 mL) of methyl alcohol, 6319, to the bottle labeled "Diluted Zinc Indicator Solution". Cap and mix the ingredients in this bottle. Do not leave this bottle uncapped.

B. DETERMINATION OF ZINC

1. Fill a clean colorimeter tube (0967) to the 10 mL line with the soil filtrate then neutralize according to the procedure on page 10.
2. Select setting 6 on the "Select Wavelength" knob and press the "30 Second Read" button.
3. Insert the tube into the colorimeter chamber and adjust to "100"%T with the "Set Blank" knob. This is the 100%T blank.
4. Remove the tube, add 0.1 g of Sodium Ascorbate (6316) with the 0.1 g spoon (0699) and 0.5 g of *Zinc Buffer Reagent (6315) with 0.5 g spoon (0698), cap and shake vigorously for 1 minute.
5. Add 3 drops of *Sodium Cyanide Solution (6565), cap and mix contents of tube.
6. Use the 1 mL pipet assembly to add 1 mL of **Diluted Zinc Indicator Solution". Cap and mix contents.
7. Use a second plain pipet (0352) to add 4 drops of *Formaldehyde Solution, 37% (5128). Cap and mix by inverting 15 times.
8. Press the "30 Second Read" button and insert the tube into colorimeter chamber. Measure the test result as soon as the reading stabilizes.
9. Consult the calibration chart to find the concentration of zinc in parts per million (ppm).

ZINC CALIBRATION CHART

%T	9	8	7	6	5	4	3	2	1	0
90										
80				0.0	0.1	0.1	0.2	0.2	0.3	0.3
70	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.9
60	0.9	1.0	1.0	1.1	1.2	1.2	1.3	1.4	1.4	1.5
50	1.6	1.7	1.7	1.8	1.9	2.0	2.0	2.1	2.2	2.3
40	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3
30	3.4	3.5	3.6	3.8	3.9	4.0	4.2	4.3	4.4	4.6
20	4.8	4.9	5.1	5.3	5.5	5.6	5.9	6.1	6.3	6.5
10	6.8	7.0	7.3	7.6	8.0	8.3	8.7	9.1	9.5	10.0
0	10.6	11.2	11.9	12.8	13.8	15.1	16.8	19.2	23.6	

ZINC CONCENTRATION CHART

%T	RANGE	PARTS PER MILLION
82-100%	Low	0-0.5 ppm
77-81%	Marginal	0.6-1.0 ppm
69-76%	Adequate	1.1-2 ppm