Chapter 11
Fertilizers

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What are fertilizers and why are they necessary?

All plants need certain mineral nutrients to survive. These minerals occur naturally in the soil and are taken up from the soil by the roots of the plants. Most soils usually have enough of these minerals to keep plants healthy. However, some nutrients are gradually used up by the plants, or are washed out of the soil, and need to be replaced to maintain optimal growth and appearance. **The most common mineral nutrients that need replacing are Nitrogen (N), Phosphorus (P) and Potassium (K).**

Fertilizers are manufactured mixtures of chemical products that contain N, P, K and other necessary nutrients. They are spread over the soil to re-supply the soil with the proper amount of these nutrients. The three numbers on the front of the fertilizer bag represent the percentage by weight of N, P and K in that particular mixture. These numbers are used to calculate how much of a particular fertilizer to apply at one time.

EXAMPLE

A typical lawn fertilizer may have the numbers 25-5-10. This means that a 100 pound bag of this fertilizer contains 25% (100 x 25%) total nitrogen, or 25 pounds of N, 5% (5 pounds) phosphorus compounds and 10% (10 pounds) potassium compounds. The three numbers are the "analysis" and are used to figure out how much fertilizer to apply.

Nitrogen is the most important mineral nutrient for healthy plant growth and the one that plants use the most. The total nitrogen in fertilizers can be supplied as nitrate compounds, ammonium compounds, or urea. Usually a combination of ammonium and urea are used. Nitrogen keeps the plants green and promotes lush leaf and shoot growth. It is important to keep enough nitrogen in the soil, but do not add too much. Thatch is the layer of brown stems and runners that build up between the soil surface and the green leafy part of the grass. As thatch gets thicker it will give a spongy feel to the lawn and as it continues to become thicker it will eventually cause the mower to sink into the grass and cut lower into the brown stemmy under layer. This is called "scalping" and causes unsightly brown spots on the grass. Scalping is a problem in highly maintained turf grasses where it is much more visible and unsightly, and where it causes temporary injury to the lawn surface. (See Chapter 5, "Mowing & Edging in Landscape Maintenance Zones.")

Eco
High nitrogen levels cause grass to grow too fast which can lead to mowing more often, heavy thatch buildup, and insect and disease problems.

There are two forms of nitrogen used in fertilizers

Quick-release fertilizers use ammonium compounds, (usually ammonium sulfate or ammonium phosphate) and pure urea. These nitrogen forms rapidly dissolve in water and are almost immediately available to the roots. Therefore they produce a rapid, but fairly short lived, green-up response. Limit the use of these types of fertilizers.

Safety!
Review MSDS (Material Safety Data Sheets) prior to working with fertilizers and always use personal protective equipment, such as gloves and safety goggles while dealing with fertilizers.

Eco
As much as possible use slow-release fertilizers instead of quick-release fertilizers.

Slow-release fertilizers contain various forms of modified urea formulated for the roots to absorb slowly. These include sulfur-coated urea, urea form and IBDU. These types of fertilizers are more expensive but less likely to burn the grass, last longer than quick-release and are less likely to leach through the soil.

Eco
All fertilizers are potentially harmful to the landscape and to the environment if misused or improperly applied. Too much nitrogen can leach through the soil and pollute groundwater. Too much phosphorous can wash into waterways through soil erosion, polluting streams and eventually the ocean reefs causing problems like algal blooms.

What kind of fertilizer will I use?

HDOT will eventually replace all slow-release fertilizers with the better and advanced technology ultra slow-release formulations; however, until then, you will be using mostly the traditional slow-release N formulations.

The ultra slow-release fertilizers are specially formulated to slowly release nutrients over a period of one year. Unlike the current slow-release fertilizers, these ultra slow-release formulations can be spread once a year in much higher amounts without danger of burning the plants.

They also do not require that the plants be watered immediately after application, so irrigation systems may not be needed in areas that are fertilized. The Engineer will supply you with these new ultra slow-release fertilizers formulated for HDOT for use on turfgrasses, trees, shrubs and palms.

Where do I apply the fertilizer?

- Fertilizing areas you are contracted to maintain will depend on the expected quality of maintenance for that area. The Engineer will determine this and include it in the specifications of the bidding process.

- Most rural areas will not need fertilization. The only rural areas needing fertilization are interchanges with turfgrass.

- Bare soil or sparsely covered slopes subject to erosion should not be fertilized.

- Areas most likely to need regular fertilization are high visibility locations with good turfgrass cover and trees and shrubs requiring extra care. Most are combinations of mixed grasses, some broadleaf ground cover, such as wedelia, and various trees and shrubs. Fertilizer application may be required once a year.

- A few locations in or near main city highways have a higher level of maintenance expectations. Most of these areas are medians with St. Augustine grass, naupaka hedges and monkeypod trees or shower trees.

- A few locations may have other plantings, such as 'El Toro' zoysia lawn grass or other species of trees and shrubs that require more specialized care. These high visibility locations must be fertilized once a year, using the special ultra slow-release fertilizers. It is desirable, but not mandatory, that areas getting fertilization have a working irrigation system.

Eco
Do not apply fertilizer over an area that is likely to be eroded, such as bare soil or on a slope, close to ditches, swales, gutters or other waterways. When applied along level roadside locations, make sure that any excess is blown back into the grass area to prevent entry into waterways through rain runoff.

How do I get the fertilizer for the job?

The State will supply you with the fertilizer for the job. You must get approval in writing from the HDOT before using fertilizers.

This approval should be a memo including the time, location, amount of fertilizer issued and the equipment to be used to apply the fertilizer. This memo should be submitted at least two weeks before applying the fertilizer. The Engineer will tell you where to pick up the fertilizer and the spreader.

The type of fertilizer you get will depend on the kind of plants and the location of your maintenance area. In lawn areas you will be given the ultra slow-release turf type fertilizer higher in nitrogen; for trees and shrubs a more balanced ultra slow-release formulation containing equal amounts of N, P and K, and a special ultra-slow formulation for palms, which is higher in micronutrients and magnesium.

Within two weeks after the fertilizing, you have to submit a record of the area you fertilized, the date applied and the amount used. This is covered in more detail in Chapter 14, "Reporting."

How do I determine how much fertilizer to use?

The amount of fertilizer needed for grass, trees, shrubs and palms is based on the amount of nitrogen (N) needed to maintain normal, healthy growth without burning the plants. This amount of fertilizer, given in pounds of nitrogen per 1,000 sq. ft., is called the recommended rate which depends upon the percentage of total nitrogen and also the type of nitrogen formulation. To determine the amount of fertilizer you need for a job you, will need to know the recommended rate. This is usually listed on the fertilizer label.

Eco
Prevent over fertilization. Always use recommended rates listed on the fertilizer labels to determine the amount of fertilizer needed for a job.

Grass

Typical recommended rates:

- Soluble quick-release fertilizers, such as ammonium sulfate, are one pound N per 1,000 sq. ft.
- Slow-release N products, such as sulfur coated urea, are 1½ pounds N per 1,000 sq. ft.
- The new ultra slow-release fertilizers supplied by HDOT can be as high as 4 to 5 pounds of N per 1,000 sq. ft. without danger of burning the grass.

Trees and shrubs

Typical recommended rates:

- Quick-release fertilizers are no more than 2 pounds N per 1,000 sq. ft. of root zone.
- Slow-release formulations are up to 3 to 4 pounds N per 1,000 sq. ft. of root zone area.
- Ultra slow-release fertilizers can go as high as 7 to 8 pounds of N per 1,000 sq. ft. of root zone. The ultra slow fertilizers will allow for one application a year. This will slowly release nutrients over the entire 12 months for all plants.

First determine the area you want to fertilize. Estimate the general shape (rectangle, triangle etc.) of the area to be fertilized. Use following standard formulas to calculate the area:

Squares and rectangles – length x width
Triangles – base x height / 2
Circle (3.14 x radius squared)

(See more examples in Appendix 11A)

Because application rates are calculated in pounds of actual fertilizer needed for 1,000 sq. ft. of area, the total amount of fertilizer needed for a given area will be different with each type of fertilizer used. Fertilizer formulations higher in total N will require smaller amounts than those with a lower percentage of N. Once you know the total area you want to fertilize, use the following formula to figure out how much actual fertilizer you will require.

$$\text{Pounds of fertilizer required} = \frac{Recommended\ amount\ of\ N}{\%\ N\ in\ fertilizer} x \frac{total\ area\ to\ be\ treated}{1{,}000\ sq.ft.}$$

EXAMPLE

Assume you have 10,000 sq. ft. of lawn area to fertilize and you are given a slow-release fertilizer formulation of 25-5-12 (25% total slow-release N) and the recommended fertilizer rate on the label is 1.5 pounds N per 1,000 sq. ft. You will need:

1.5/0.25 x 10,000/1,000 = 60 pounds of slow-release 25-5-12 fertilizer

For the same 10,000 sq. ft. area, if using an ulta slow-release HDOT fertilizer formulation of 18-5-10 with the recommended rate on the label of 4 pounds of N per 1,000 sq. ft., you will need:

4/0.18 x 10,000/1,000 = 222 pounds of ultra slow-release 18-5-12 fertilizer

Eco
When spreading the fertilizer, do not apply more than the calculated rate. Conserve resources and protect the environment.

The Engineer may make the calculations for your particular plots and determine the amount of fertilizer required for your job. This information will be included in the original directions and forms given to you when you are assigned the location at the beginning of your contract. The area to be fertilized will be estimated by the Engineer using the method described in Appendix 11A.

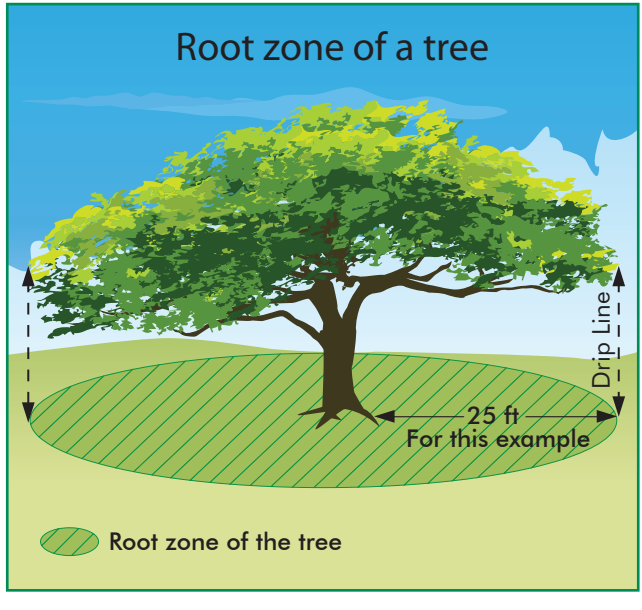
If you apply more than the calculated amount of fertilizer, it can cause fertilizer burn and kill the plants. You are responsible for any damage to the landscape as a result of misuse of fertilizers.

How to determine root zone

To determine how much fertilize to use for individual trees, shrubs and hedges, you will first need to know the root zone area. The root zone is usually taken as the area under the drip line of larger trees, or an area that extends 10 ft. from the trunk of small trees and shrubs. This area will be in the form of a circle for free standing trees and shrubs or in the form of a rectangle around hedges and shrubs in planting beds.

To calculate this area for free-standing trees, measure the distance from the trunk to the outer edge of the overhanging branches (this is called the drip line). This area will be in the form of a circle. Using the formula to calculate area of a circle, multiply this drip line distance (radius) times itself and then multiply that number times 3.14 (value for Pi). This will give the circular area under the drip line to be fertilized. See illustration below.

How to determine the area to fertilize under a tree



How to determine the amount of fertilizer to use under a tree

For example let's assume we are using an ultra-slow fertilizer such as 17-5-11 and we are following the label recommendation for trees of 6 pounds N per 1,000 sq. ft. of root zone.

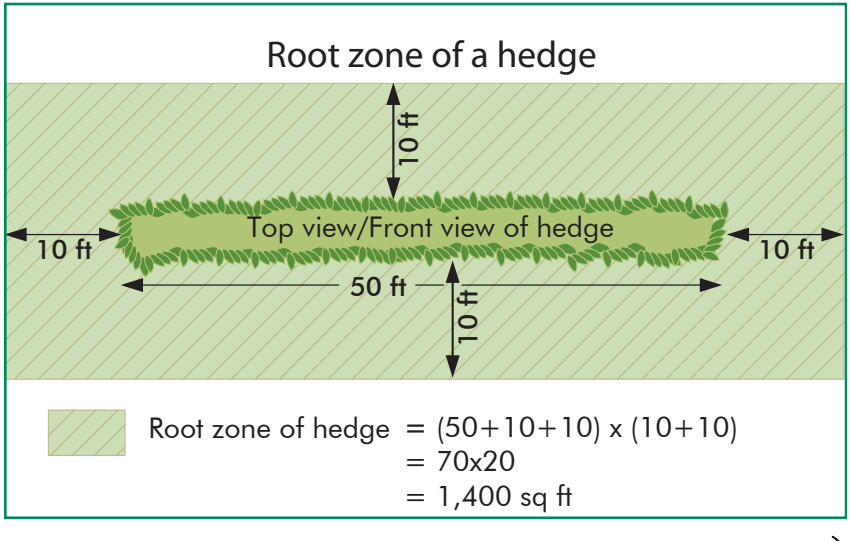
Use the fertilizer application formula:

$$\text{Pounds of fertilizer required} = \frac{Recommended\ amount\ of\ N}{\%\ N\ in\ fertilizer} x \frac{total\ area\ to\ be\ treated}{1{,}000\ sq.ft.}$$

$$= \frac{6}{0.17} x \frac{1{,}962.5}{1{,}000} = 69.2\ pounds$$

So the amount of 17-5-11 fertilizer to be spread evenly under the drip line of the tree with root zone areas of 1,962.5 sq. ft. is 69.2 pounds.

How to determine the area to fertilize under hedge



How to determine how much fertilizer to use for a hedge

For example, let's assume we are using an ultra slow 17-5-11 formulation with a label recommendation of 6 pounds N /1,000 sq. ft. of root zone.

Use the fertilizer application formula:

$$\text{Pounds of fertilizer required} = \frac{Recommended\ amount\ of\ N}{\%\ N\ in\ fertilizer} x \frac{total\ area\ to\ be\ treated}{1{,}000\ sq.ft.}$$

$$= \frac{6}{0.17} x \frac{1{,}400}{1{,}000} = 49.4\ pounds$$

So the amount of 17-5-11 fertilizer to be spread evenly under the hedge with root zone areas of 1,400 sq. ft. is 49.4 pounds (hatched area above).

How to determine how much fertilizer to use for palms

Clumping palms, such as areca and McArthur, can be fertilized using the same method as for hedges. The actual amount used for each application will depend on the kind of fertilizer; follow the label recommendation.

Large single trunk palms, such as coconut and royal palms, are fertilized according to the trunk caliper (diameter of the trunk measured at 4 ft. above the ground), or by the height of the trunk measured from ground to crown. The label on the ultra slow-release formulation for palms should give the amount to use. Refer to the label.

When do I spread the fertilizer?

If you use the new ultra slow-release fertilizers

- Once a year for all grass, trees, shrubs and palms.
- Apply fertilizer during the month of March.
- Avoid applying during long rainy periods.

If you use traditional slow-release fertilizers on grasses

- In areas where the grass is a mixture of common Bermuda grass, Hilo grass, carpetgrass or wild type weedy grasses, one application per year at the recommended rate for slow-release N should be enough for maintenance.
- The best time for an annual fertilizer application in Hawaii is March.

How often you apply fertilizer will also depend on the general location; rural areas may not require any fertilization. In areas where pure stands of one of the warm season turfgrasses are being used, more than one application of slow-release N at the recommended rate per year may be required. These likely will be located in high visibility urban areas.

- For hybrid Bermuda grass and seashore paspalum – three times per year in March, June and September.
- For zoysia and St. Augustine grass – two times per year in March and August.

If you use traditional slow-release fertilizers on trees and shrubs

- Ornamental shrubs and small trees should be fertilized two times per year, in March and August, during the first three years after planting.
- Established trees and shrubs do not need additional fertilization if they are surrounded by turfgrass that receives fertilizer at least once a year. Otherwise, established trees and shrubs should be fertilized once a year.

Fertilizing native plants

Most of the native and canoe (culturally significant plants in Hawaii introduced by Polynesians) plants used on Hawaii roadsides are naupaka, aalii, pohinahina, and milo. Native species do not need extra or special fertilizer requirements. An annual application of the ultra slow-release tree/shrub fertilizer supplied by HDOT at the recommended rate is all that is necessary.

Safety!
Always use personal protective equipment, such as gloves and safety goggles, when dealing with fertilizer.

How do I safely apply fertilizer?

- When using any fertilizer other than the ultra slow-release formulations, the irrigation system must be in working order.
- A day or two before fertilizing, water well; if no irrigation system is present, apply fertilizer several days after a good rain.
- Mow grass a few days before fertilizing. Do not mow immediately after fertilizing.
- Do not apply fertilizer to wet grass or to grass that is too dry.

The fertilizer used should be either a slow-release N formulation or an ultra slow-release form. Both are made as small prills to dissolve and release nutrients slowly. These prills must not be broken. If the grass is mowed before the fertilizer prills can move down to the soil line by irrigation or other physical means, the fertilizer will be chopped up and all the nutrients will be released at one time. This will shorten the activity of the fertilizer and, most likely, also result in burning the grass.

Remember
You are responsible for any damage to the landscape as a result of misuse of fertilizer. You may be penalized for damages.

- Use a calibrated rotary spreader (see how to calibrate in this chapter). Do not spread fertilizer by hand!
- Use correct application pattern and overlap distances. (See section below.)
- Blow fertilizer granules off of roadsides or sidewalks onto grass.
- Irrigate for 15 minutes immediately after applying fertilizer if irrigation system is present.
- Ultra slow fertilizers do not need immediate watering and, therefore, must be used in areas with no irrigation.

Tip
If the fertilizer is not spread evenly, areas that get too much will be burned and areas that get too little will show uneven greening. Use a sturdy, easily calibrated rotary-type commercial spreader. HDOT will loan you the recommended spreader or give you the specifications for ones purchased. Use the recommended type of spreader because the calibration instructions will be specific to that piece of equipment.

Eco
Do not place the spreader directly on grass surface to fill the hopper with fertilizer. Place spreader on paved or bare surface with a plastic sheet underneath, then fill the hopper with the weighed fertilizer. If there is any accidental spillage on the plastic, carefully pick up the corners of the plastic so that the excess spillage moves toward the center of the plastic; gather and recycle/reuse this spilled fertilizer. Sweep up any minor spills from paved or bare surfaces. In case of spillage on grass; remove as much as possible and flush well with water to prevent chemical burn and pollution.

The recommended spreader

Use smaller hand or belly spreader for narrow medians and hard to get at places. These spreaders will hold 5 pounds to 25 pounds of fertilizer.

Use wheeled push spreader for larger flat areas along roadside or large medians. This spreader will hold up to 125 pounds of fertilizer. These areas may be harder or unsafe to access with a vehicle to pull a spreader, or when a vehicle is not available, but are small enough to comfortably cover with a push type walk-behind spreader.

Push type walk-behind spreader

Use a tow-behind broadcast spreader that can be pulled by a small garden tractor or cart for very large areas, such as interchanges or wide and long roadsides. This spreader holds up to 200 pounds of fertilizer.

Tow-behind broadcast spreader

What is calibration?

Before you start, here is what you need:

- Scale
- Spreader
- Fertilizer
- Tape measure
- Open bare or paved area

Calibration is the method used to make sure that the right amount of fertilizer is being applied. Calibration of the spreader depends on three things:

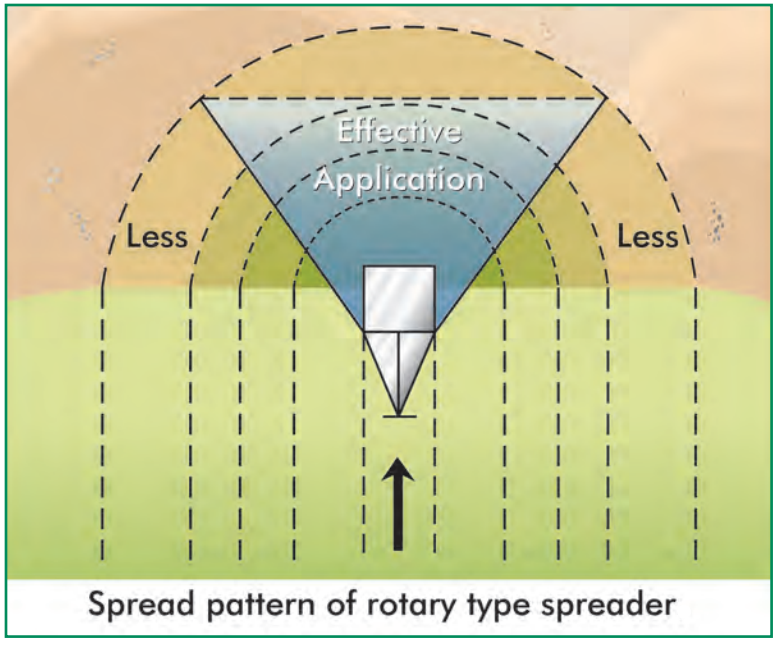
- The type of spreader being used
- The kind of fertilizer being used
- How fast the spreader is pushed or pulled over the area (operator speed)

The type of spreader and the kind of fertilizer used may or may not be the same type. The third factor (the operator) will depend on how fast the spreader is being pushed or pulled with a small vehicle. It is important to keep a steady, comfortable speed.

The rotary spreader has a lever that controls the size of the opening in the bottom of the hopper and the amount of fertilizer that is released.

The suggested settings for the most commonly used spreaders are usually printed on the fertilizer bag. This setting will distribute the approximate recommended amount of fertilizer assuming the operator is walking at a designated constant speed.

Rotary spreaders do not apply a constant amount of fertilizer across the entire width of the application pattern. More material is applied toward the center and less at the edges. The "effective width" for a constant application rate is about the inner 2/3 of the throw.



Showing effective application width

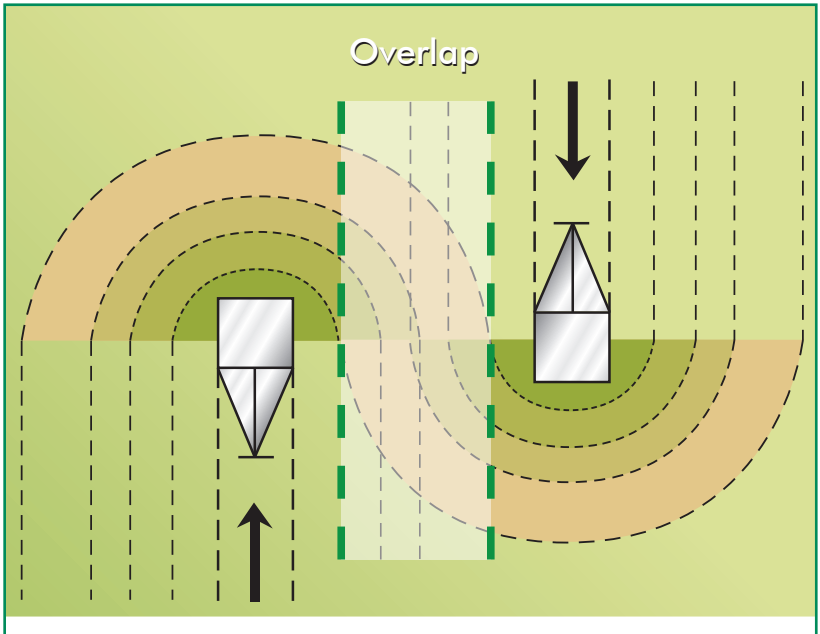
The first step in calibrating the spreader to find the exact setting is to determine the "effective width" of throw. To do this, follow these steps:

- Check the spreader to make sure all parts are operating properly.
- Fill the hopper about half full with the fertilizer you plan to use. Set the spreader at the suggested setting and then begin spreading it on bare ground or hard surface where the width of throw can be measured. Measure the average width of the application pattern and multiply by 0.67. This is the effective width. When spreading the fertilizer in actual practice, the outer edges should be overlapped by 2 ft. to compensate for the lesser amount.

***EXAMPLE* – How to determining effective width**
If the total application width is 12 ft., then the inner 8 ft. (12 x 0.67) are receiving about the same amount of fertilizer and the outer 2 ft. on either side of the pattern are getting less.

Tip

To consistently obtain uniform spread of fertilizer, remember to overlap during application so that the outer edges receive an equal amount as in the effective spread. If the effective width is 10 ft., move the spreader over 10 ft. after each pass. This will allow for the correct overlap.



Overlapping several feet at the edge of the fan of material

Eco

If you use a paved surface for the test strip, be sure to sweep up all of the fertilizer after you are finished.

- Once the effective width is determined, measure out a plot that is as wide as the effective width and has a total area of 1,000 sq. ft. To determine how long the plot should be, divide 1,000 by the effective width; the calibration is now being based on the effective width of the spreader.

EXAMPLE – How to determine size of test strip

In this case the total width was 12 ft. and the effective width was 8 ft. The test strip should be 8 ft. wide and 125 ft. long (1,000/8).

- Determine the amount of fertilizer to be applied to 1,000 sq. ft. based on the recommended rate and the formulation of the fertilizer.

EXAMPLE – Calibration trials

Assume the recommended rate is 1.5 pounds of N using 25-5-5. (1.5/0.25 = 6 pounds of fertilizer for 1,000 sq. ft.)

- Accurately weigh out enough fertilizer to fill the hopper to about half full. Adjust the spreader to the recommended setting on the fertilizer bag. Push the spreader down the middle of the test strip, opening the hopper at the beginning and closing it at the finish. Weigh the unused fertilizer after covering the designated area and subtract that amount from the starting weight in the hopper to determine how many pounds were applied. The beginning weight minus the ending weight tells how much was applied. Compare this amount with the calculated amount and make adjustments to the spreader setting if necessary. Repeat the trial run and continue making adjustments until the calculated amount of fertilizer is consistently applied over 1,000 sq. ft. Once the spreader is calibrated, record the setting and the specific fertilizer product for future reference. As long as the operator speed remains constant, the correct amount of fertilizer always will be applied.

EXAMPLE – How to read the trial results

Weigh out 20 pounds of fertilizer into the hopper. Adjust the calibration lever at the recommended setting on the label which, let's say, is 10. At the end of the trial run over the 1,000 sq. ft. test plot, you weigh

what is left and find a total of 15 pounds. This means that you have spread 5 pounds of fertilizer (20–15=5). The calibrated amount should have been 6 pounds. You now need to readjust the calibration lever to release more fertilizer. Increase the lever setting to 11 and retry the trial spreading until you get 6 pounds spread over the 1,000 sq. ft. test plot.

EXAMPLE – Calibrated application routine

HDOT has supplied you with a 50 pound bag of the Super Turf 25-5-5® and an Earthway® brand rotary push spreader to fertilize 8,000 sq. ft. of common Bermuda grass at the normal recommended rate of 1½ pounds of N per 1,000 sq. ft.

The Engineer has used the application calculation formula to determine that one 50-pound bag of fertilizer will be enough for the area you are to fertilize (1.5/0.25 x 8,000/1,000 = 48 pounds of fertilizer). Review the fertilizer label on the bag. See "Appendix 11B: HOW TO READ A FERTILIZER LABEL."

Notice the following information:

Recommended rate of N for this product is 1.5 pounds/1,000 sq. ft. recommended setting on Earthway® spreader for 1.5 pounds is 16 (at 1.5 #N using 25-5-5 will need 6 pounds per 1,000).

After going through the calibration procedure, let's assume you have determined that a setting of 13 works best for your spreader speed. At this point, load the 50 pounds of fertilizer into the hopper, set the lever at 13 and begin walking at a constant speed. By the end, you will be almost out of fertilizer.

Use the correct spreading techniques

- Start by spreading along the edges of the grass, making sure no excess is thrown onto the sidewalk or roadside. Two passes around the perimeter are recommended.
- Walk at the speed you used for calibration.
- After making the passes along the edges, move back and forth along the longest sides of the area.

- Make sure to overlap at the distance that was determined when you did the test plot.

- Close the hopper each time you stop or turn around. If the hopper remains open when you stop or turn, the fertilizer will continue to pour out in one spot and cause severe grass burn.

- When you finish, clean the empty spreader with a hose; otherwise, the spreader will corrode. Use the lawn area to wash and let spreader dry before storing. There are a few other spreader operation techniques to learn. You will get further information and some hands-on training before you are allowed to make your first application.

Why and how do I take a soil sample?

In most cases, testing the soil will not be necessary. If the area to be fertilized is one designated as high maintenance and if there are obvious signs of problems, get a soil test and expert recommendation for correct fertilizer formulations.

Look for plants that show symptoms of nutrient deficiency. Look for grass, shrubs and trees with yellow leaves or leaves with yellow and green stripes. Report any areas that constantly have bare soil. Take a soil sample and record any other possible reasons for the bare condition.

Tip
Bare soil is most likely caused by situations other than poor fertilization – too dry, too shady, poor drainage, soil compaction, erosion of top soil, heavy wear from foot or equipment traffic, etc. Observe these possibilities and report them to the Engineer along with the soil test.

Use private service providers or the University of Hawaii Agricultural Diagnostic Service Center (ADSC) for soil diagnosis. Instructions for taking the soil sample and for submitting the sample will be provided to you at the beginning of your contract period.

A soil analysis can help determine the source of some problems with plant health. Here are three important soil characteristics:

- **Soil pH**
  This is a measure of how acidic (low pH) or alkaline (high pH) the soil has become. This is measured on a scale of 0 to 14, 0 being very highly acidic and 14 very highly alkaline.

  Most soils fall into the range of 4.0 to 8.5. The most desirable pH for most tropical plants is between 5.5 and 7.0. Soil tests indicate pH problems and will give recommendations for correcting them.

- **Available nutrient levels**
  A basic soil test will also give the levels of some of the major soil nutrients. These are Phosphorus (P), Potassium (K), Calcium (Ca) and Magnesium (Mg). Nitrogen is not included in the basic test and is usually assumed to be low and in need of replenishment.

- **Soil Salinity**
  A soil measurement that is often very helpful is soil salinity and should be included as an extra test when you submit your soil sample to the testing lab. This is a measure of the total amount of salts in the soil water.

Tip
With the use of brackish and reclaimed irrigation water, the salts can build up and begin to burn the landscape plants. This can also happen as a result of over fertilization.

How to take a soil sample:

Soil tests are done on a very small portion of the entire soil area. The samples should be taken from areas that are similar in appearance and plant cover. If large differences can be seen in the overall sampling area, take separate samples that represent each of the different parts. Reasons to take separate samples can include differences in soil color and texture, land slope, soil drainage and compacted areas. Each sample submitted should be a combination of five to 10 smaller samples from the same general area.

Tools and equipment needed

Make a rough map of the area if you are taking more than one representative sample. Mark each area on the map and on the sample bag and include a label with this information in the bag.

- Spade or shovel preferably made of steel.
- Plastic bucket to mix the samples before putting a smaller sample into a plastic bag.
- Plastic bag to hold the final mixed sample. A regular zippered plastic bag works well.
- Waterproof marker to label sample bags.

How deep to sample

For turf areas take the sample from the top 4 inches.
For trees and shrubs take the sample from the top 8 inches.

The sampling method

- Clear surface of soil of any plant growth or other plant litter.
- The sample should only contain soil.
- Dig a square hole as wide as your spade and as deep as the recommended depth.
- Remove a 1-inch thick slice from one side of the hole with the spade. Keep the slice on the spade and remove a 1-inch square of soil from the middle of the slice with a trowel or knife.
- Place this small sub-sample in the plastic sample bag.
- Dig five to 10 more holes in the area and mix the sub-samples together in the sample bag. The total sample should fill the bag about 2 cups).

Keep the sample dry. Do not sample on a wet day. Submit the sample and information form to the testing lab right away. Allow two to three weeks for a result. Request the Basic Analysis and the Soil Salinity test.

Suggested lab:
Agricultural Diagnostic Service Center
College of Tropical Agriculture & Human Resources
1910 East-West Rd., Sherman Lab 134, Honolulu, HI 96822
Phone: 956-6706/7980 Fax: 956-2592
E-mail: adsc@ctahr.hawaii.edu
http://www.ctahr.hawaii.edu/TPSS/research_extension/rxsoil/soilsample.htm

How do I get training?

Before you are allowed to apply fertilizer, you must attend specialized HDOT courses covering best management practices related to storm-water requirements and for fertilizer calibration, application and safety. Contact the HDOT Engineer in charge of maintenance in your area to find out about the training requirements and schedule. The manual for the stormwater course is available at:
http://www.stormwaterhawaii.com/program_plan/pdfs/app_h1.pdf

Reporting & Inspection

You and your crew are required to keep a log of the time spent fertilizing the vegetation, amount of fertilizer used and the locations where applied. You are required to complete the fertilizer usage log forms provided in this program plan and to deliver the completed forms and empty fertilizer bags to Highways Division within three days after spreading the fertilizer, or with invoices as determined by the Engineer. See Chapter 14 "Reporting" for Fertilizer Use Log and Disposal of Expired Landscaping Chemical Log.

HDOT inspectors or other staff members authorized by the Engineer to visit the State ROW have the right to visit your site to ensure you follow the standards for using fertilizers as discussed in this chapter. Fertilization inspection will be done within two weeks of the actual application. The inspector will check if the landscape is healthy and showing no signs of nutritional deficiency and damage due to chemical burn. See Chapter 15, "Inspecting Vegetation Maintenance Work."

In a Nutshell

1. Most common mineral nutrients that need replacing are: nitrogen (N), phosphorus (P), and potassium (K).
2. Never over fertilize. Always use the fertilizer rates recommended on the label.
3. Use slow-release instead of quick-release fertilizers as much as possible to avoid fertilizer burn and leaching through the soil.
4. Take measures to prevent fertilizers from entering storm drains and waterways.
5. Never spread fertilizer by hand.

Appendix11A

Estimating Roadside Vegetation Area

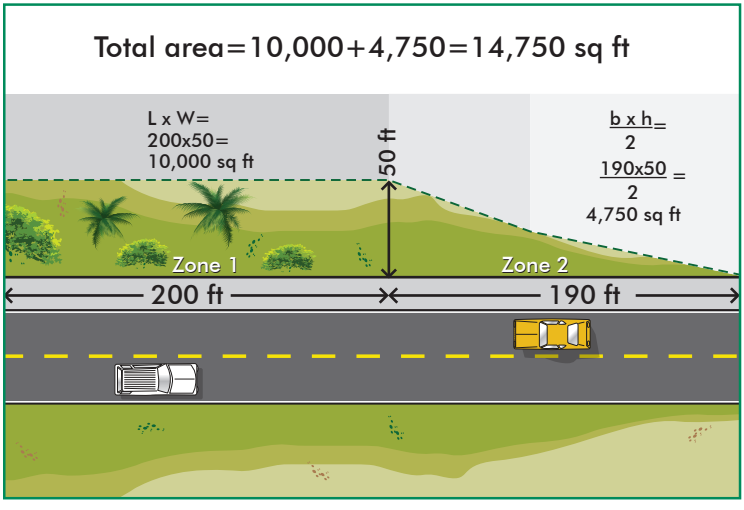
Estimating a small area that can be split into regular-shaped units

Roadside vegetation areas with fairly uniform rectangular shapes can be estimated using the formula of length multiplied by width (L x W). This is a simple matter of taking accurate measurements. It may be necessary to divide the entire location into smaller uniform spaces if significant differences in sizes exist within the entire section. Some parts of the total section may not be rectangular but more triangular in shape. In this case, the formula for calculating the area of that portion is base times height divided by 2 (w x h)/2. The base is measured as the distance along the roadside and the height is measured as the perpendicular distance from the base to the intersection of the other two sides.

EXAMPLE *(Refer to diagram below)*

Assume there are two uniform areas within the vegetation zone. Zone One is 200 ft. long and 50 ft. wide; Zone Two is triangular with a base length of 225 ft. and a height of 50 ft.

The total area is calculated by adding area of Zone One 10,000 sq. ft. (200 x 50) plus area of Zone Two; 4,750 sq. ft. (225 x 50/2) for a total vegetation area of 14,750 sq. ft.

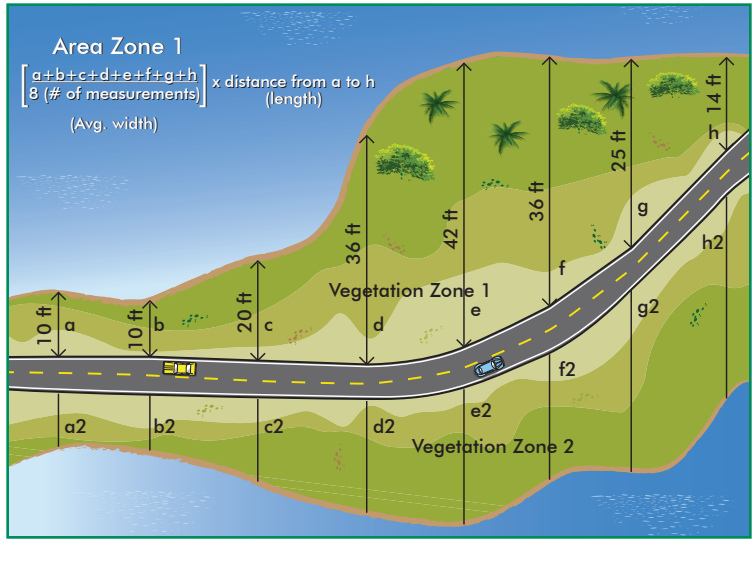


Estimating area of roadside vegetation in an irregular shape

Parts of many roadside vegetation zones extend to greatly different distances from the roadside to the outer boundary of the zone. In this case, just one measurement of the width cannot be used to estimate area. The area can be estimated by what is called the "offset method." The length can be measured accurately as the distance from one end of the location to the other. The width is estimated by taking a number of measurements at convenient regular intervals from the edge of the road to the outer boundary. An average of these width measurements is determined by dividing the sum of the measurements by the number of measurements. This is taken as the average width and the L x W area formula gives the estimated area for the vegetation zone.

EXAMPLE *(Refer to diagram below)*

The road is a divided highway. The distance along the road in vegetation Zone 1 measures 1,050 ft. This distance is used as the length in the area calculation of a rectangle (L x W). The width measurements "a" through "h" are taken at regular 150 ft. intervals. The average width will be estimated using the sum of the measurements of these lines and dividing that sum by the number of measurements; in this case, 8. Assume the distances for "a" through "h" are measured to be 10, 10, 20, 36, 42, 36, 25, 14 ft., respectively. Adding these distances gives a sum of 193 ft. and dividing by the number of measurements (8) gives an average width of 24 ft. The L x W formula is calculated as 1,050 x 24=25,200 sq. ft. in this vegetation zone. Zone 2 area is calculated the same way.



Appendix 11B

How to Read a Fertilizer Label

BEST SUPER TURF 25-5-5 with POLYON 43

Simplot Professional Products

DESCRIPTION: A PREMIUM, DRY-APPLICATION, CONTROLLED-RELEASE LANDSCAPE FERTILIZER FEATURING A TRI-PARTICLE BLEND OF POLYON® (POLYMER-COATED UREA), TRIKOTE® (POLYMER-COATED SULFUR-COATED UREA) AND TURF SUPREME®.

BENEFITS: SUPER TURF 25-5-5:

2
- **SUPERIOR BLEND**–includes the most essential turf nutrients–nitrogen, phosphate, potash, sulfur and iron– in a stain-resistant homogeneous pellet.
- **EXTENDED NITROGEN FEEDING**–56% of the nitrogen is from Polyon and TriKote (polymer-coated granules), which provide up to 12 weeks of turf response.
- **DRY APPLICATION**–Super Turf N-P-K granules provide a watering window of up to 24 hours before there's a danger of burning.
- **LABOR SAVING**–longer-lasting, controlled-release nitrogen means fewer applications and a slower growth rate, requiring less mowing time.
- **SAFE AND VERSATILE**–proven technology that is ideal for schools, parks, cemeteries, golf courses and a professional lawn care applications.

APPLICATION RATES:

	Pounds of N to apply per	Pounds of Super Turf® to apply per	Pounds of Super Turf® to apply per
Turfgrass:	1.00	4.0	175
*Recommended Rate	.75	5.0	220
	3a 1.50	6.0*	260*

POLYON TECHNOLOGY INSIDE

TRIKOTE TECHNOLOGY INSIDE

NITROGEN/SULFUR BLEND BEST PELLET

3 **PREPLANT:** Broadcast 6 lbs. per 1,000 sq.ft. (260 lbs. per acre).
GROUNDCOVER: Broadcast at 4 lbs. per 1,000 sq.ft. (¼ lb. per 100 sq.ft.).
SHRUBS & EVERGREENS: Sprinkle ¼ cup evenly around dripline of plant and work into top 1 inch of soil.
TREES: Apply 1/3 lb. per inch of trunk diameter. Distribute evenly under branches out to dripline.
NOT RECOMMENDED FOR NURSERY APPLICATION.
NOTE: Liquid measuring cups are very close in estimating the weight of dry granular fertilizers.
Example: an 8 oz. (1 cup) measuring cup holds approximately 8 oz. of dry granular fertilizer.

4 **PRODUCT COVERAGE:**
Based on the Recommended Turfgrass Rate
One 50 lb. bag covers 8,300 - 12,500 sq.ft.
3½ - 5 50-lb. bags cover one acre.

Tech sheets, MSDS and other information on BEST products available at www.bestfertilizer.com

SPREADER SETTINGS:

5 *Listed Settings Will Approximately Apply the Recommended Rate.*

BEST® Pro	5½B
Spyker / BEST® Models 34, 44, 64	5
Earthway	16
Lesco	N
Scotts R-8A (Cone 5)	O
Lely 1250 / Vicon	visit www.bestfertilizer.com
SGN 250	

NOTE: Spreader settings are guidelines only. Spreaders should be checked for accuracy.

APPLICATIONS PRECAUTIONS:

6
- Iron and other plant nutrients can stain sidewalks. Sweep walkways prior to irrigation. Walkways should be dry at time of application.
- Keep away from pools, ponds, etc. Do not contaminate potable water.
- Do not apply with a drop-type spreader. The grinding action of these spreaders destroys the coating of the sulfur-coated urea and will increase the burn potential.

7 GUARANTEED ANALYSIS:

TOTAL NITROGEN (N)	25.00%
7b 10.3% Ammoniacal Nitrogen	
14.7% Urea Nitrogen*	
7a AVAILABLE PHOSPHATE (P_2O_5)	5.00%
9 SOLUBLE POTASH (K_2O)	5.00%
Sulfur (S)	10.50%
0.5% Free Sulfur (S)	
10 10.0% Combined Sulfur (S)	
Iron (Fe)	0.90%
Manganese (Mn)	0.10%

11 Derived from Polymer-Coated Urea, Polymer-Coated Sulfur-Coated Urea, Ammonium Sulfate, Monoammonium Phosphate, Muriate of Potash, Iron Oxysulfate and Manganese Oxide.

12 14.0% Slowly available urea nitrogen from polymer-coated urea and polymer-coated sulfur-coated urea.

8

TRADE MARKS: POLYON are registered trademarks of Pursell Technologies, Inc., Sylacauga, Alabama. Used by permission.

Information regarding the contents and levels of metals in this product is available on the Internet at http://www.regulatory-info-jr.com

PACKAGE SIZE: 50-LB. (22.68-Kg.) BAGS MANUFACTURED IN U.S.A 74003BAG (PRG/TB R11-8-05)

HANDLING PRECAUTIONS: CAUTION: KEEP OUT OF THE REACH OF CHILDREN.
MSDS - See Reverse HARMFUL IF SWALLOWED - DO NOT INHALE; STORE IN DRY PLACE.

Products For: LANDSCAPE • GOLF COURSE • HORTICULTURE • LAWN CARE • SOD PRODUCTION

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1. The label shown above is an example of the information shown on a typical fertilizer bag. In this case the brand name is Super Turf 25-5-5. **The three numbers after the trade name are very important information. These numbers represent the percent of the main nutritional minerals provided in the fertilizer formulation. These are total nitrogen (N), available phosphorus (P), and soluble potassium (K). These numbers are always listed in the order of N, P, K.** In the fertilizer shown in the example, the percentage of nitrogen (N) is 25%, phosphorus (P) is 5% and potassium (K) is 5%. Other nutrients and information are generally given on different parts of the label.

Other valuable information given on fertilizer labels includes general details about the particular type of fertilizer in the bag.

DESCRIPTION: A PREMIUM, DRY-APPLICATION, CONTROLLED-RELEASE LANDSCAPE FERTILIZER FEATURING A TRI-PARTICLE BLEND OF POLYON® (POLYMER-COATED UREA), TRIKOTE® (POLYMER-COATED SULFUR-COATED UREA) AND TURF SUPREME®.

BENEFITS: SUPER TURF 25-5-5:

- **SUPERIOR BLEND**–includes the most essential turf nutrients–nitrogen, phosphate, potash, sulfur and iron– in a stain-resistant homogeneous pellet.
- **EXTENDED NITROGEN FEEDING**–56% of the nitrogen is from Polyon and TriKote (polymer-coated granules), which provide up to 12 weeks of turf response.
- **DRY APPLICATION**–Super Turf N-P-K granules provide a watering window of up to 24 hours before there's a danger of burning.
- **LABOR SAVING**–longer-lasting, controlled-release nitrogen means fewer applications and a slower growth rate, requiring less mowing time.
- **SAFE AND VERSATILE**–proven technology that is ideal for schools, parks, cemeteries, golf courses and a professional lawn care applications.

2. General description and benefits of formulation gives details on specific make-up of chemicals and how to properly use the fertilizer.

APPLICATION RATES:

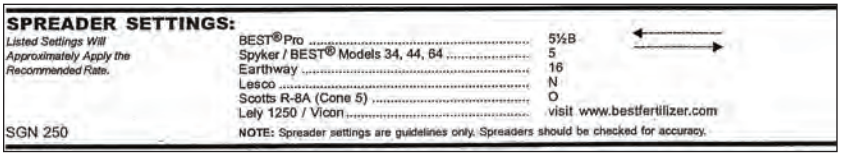
	Pounds of N to apply per	Pounds of Super Turf * to apply per	Pounds of Super Turf * to apply per
Turfgrass:	1.00	4.0	175
*Recommended Rate	1.25	5.0	220
	1.50*	6.0*	260*

PREPLANT: Broadcast 6 lbs. per 1,000 sq.ft. (260 lbs. per acre).
GROUNDCOVER: Broadcast at 4 lbs. per 1,000 sq.ft. (¼ lb. per 100 sq.ft.).
SHRUBS & EVERGREENS: Sprinkle ¼ cup evenly around dripline of plant and work into top 1 inch of soil.
TREES: Apply 1/3 lb. per inch of trunk diameter. Distribute evenly under branches out to dripline.
NOT RECOMMENDED FOR NURSERY APPLICATION.
NOTE: Liquid measuring cups are very close in estimating the weight of dry granular fertilizers.
Example: an 8 oz. (1 cup) measuring cup holds approximately 8 oz. of dry granular fertilizer.

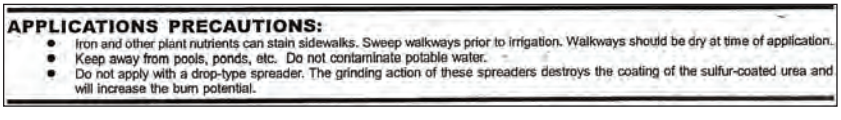
POLYON TECHNOLOGY INSIDE
TRIKOTE TECHNOLOGY INSIDE
HOMOGENEOUS BEST PELLETS

3. Application Rates: This is very important information.
The application rate is used to calculate how much fertilizer will be applied over a given area. The recommended application rates indicate the safe amount of fertilizer to apply at one time. The rates are given in pounds of nitrogen per 1,000 square ft. of lawn and also in pounds of the fertilizer required per 1,000 sq. ft. or per acre. The preferred rate (***3a***) is indicated by * and based on the amount of slow-release N that is safe to apply at one time.

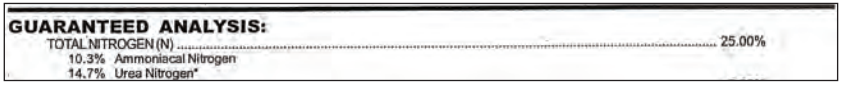
4. Product Coverage is an estimate of the total area this particular bag of fertilizer will cover if it is applied at the recommended rate.



5. Spreader Settings give an approximate setting to use with several common fertilizer spreaders. This is very important information to use when calibrating any spreader (see the section on Calibration).



6. Application Precautions gives safety information and more information on how to use the fertilizer.



7. Guaranteed Analysis
This section gives more specific information about all of the nutrient elements in the fertilizer, most important is the forms of nitrogen compounds that are used.

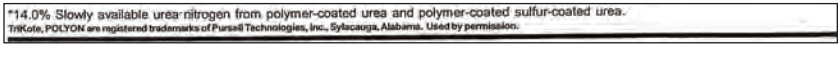
- **7a** *Total percentage nitrogen in the bag.*
- **7b** *Portion of total N that is in fast-release ammonium form.*
- **7c** *Portion of total N that is a slow-release form (slow release indicated by *). This is always a form of urea.*

8. Total percentage of available phosphorus in the bag (P2O5).

9. Total percentage of soluble potassium in the bag (K2O).

10. Other nutrients of importance in the bag.

11. Raw materials used to make fertilizer formulation.



12. Additional information on formulation of slow-release urea nitrogen from* above.

NOTE: The higher the percentage of these slow-release nitrogen forms the better. This provides a slow controlled release of the N which will provide a slow even growth rate and less chance of fertilizer burn damage to the grass. Fast-release ammoniacal nitrogen and sulfur nutrients give fast early green-up.