Tropical Turfgrass Fertilisation

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Proper fertilisation is essential for tropical turfgrasses, yet this management practice is often overlooked or misunderstood. Turfgrass nutrient deficiencies result in poor quality (low density, off colour), poor traffic tolerance, and susceptibility to weeds, diseases, and insects. Applying the correct amount of fertiliser depends not only on knowing nutrient requirements of turfgrasses, but also understanding how to calculate fertiliser application amounts, and properly calibrate fertiliser spreaders or sprayers.

Essential Plant Nutrients

Though there are 16 essential nutrients required for turfgrass growth, only a few are commonly deficient, requiring fertilisation. Macronutrients nitrogen (N), phosphorous (P) and potassium (K) are needed in largest amounts, and will be deficient unless a regular fertilisation program is followed.

Of the macronutrients, nitrogen is needed in largest amount and is typically deficient in Singapore soils. Deficiency symptoms include loss of green colour and yellowing, slow growth, loss of density (thinning out), and susceptibility to *Curvularia* (dollar spot) fungus (Fig. 1).

Top left to right: Fig 1. Symptoms of nitrogen deficiency, include a) loss of green colour and density, and b) susceptibility to *Curvularia* (dollar spot) fungus

Bottom: Fig 2. Symptoms of phosphorous deficiency, include purpling of older leaves and slow growth

Phosphorous deficiency, appearing as a purpling of older leaves (Fig. 2), is also common in Singapore, due to low soil pH. Under acid soil conditions (pH < 6), P is tied up in the form of iron and aluminum phosphates, and thus unavailable to plants.

Potassium deficiencies are also common, as K is readily leached in high rainfall tropical soils. Symptoms are less obvious, including browning of older leaf margins, loss of turf density, shallow rooting, loss of environmental stress tolerance (ex. loss of drought tolerance), and increased susceptibility to diseases and insects.

Secondary nutrients, needed in smaller amounts, include calcium (Ca), magnesium (Mg), and sulfur (S). Calcium is generally deficient in tropical acid soils, requiring adjustment of pH by addition of lime (calcium carbonate) or other alkaline sources. Magnesium and sulfur are generally not deficient, though a soil test is needed to determine this.

Soil land and Plant Tissue Testing

Soil testing is necessary to optimise soil fertility for healthy turfgrass. Testing must be done prior to planting, as well as on a repeated basis (preferably annually) after planting. Preplant testing is necessary to determine the need for pH adjustment and phosphorous requirement. Soil pH and phosphorous amendments should be mixed throughout the rootzone prior to planting, as they are immoble in soils. The amount of lime (to correct acid soil) or sulfur (to correct alkaline soil) must be given by a soil testing lab, as this depends not only on pH, but also soil buffering capacity (cation exchange capacity). In general, pH should be kept within the range of 5.5 – 7.

Soil testing should be done by taking core samples to a depth of 15-20 cm, in grid-like fashion, throughout the area (Fig 3). Remove the living material (shoots, thatch, and roots) from the sample, allow soil to dry, then thoroughly mix cores into a 500 gram batch sample to send to lab. If it is known that more than one type of soil is present on-site, then these should be sampled separately. Allow time for sample results to return by sampling the rootzone well in advance of planting. Plant tissue sampling is also a valuable tool, providing an instant snapshot' of the nutrient status of the turfgrass. Low values alert the manager to soil nutrient deficiencies.

Fig 3. Taking a soil sample for nutrient testing

Fertiliser Requirements

Fertiliser requirements for tropical turfgrasses are quite different than other landscape plants, as nitrogen requirements are much higher. 'Fertiliser ratio' is the ratio, by percentage weight, of the 3 macronutrients nitrogen (as N), phosphorous (as P_2O_5), and potassium (as K_2O). An ideal fertiliser ratio for tropical turfgrass is 4:1:2, in comparison to a typical landscape (tree and ornamentals) fertiliser having a ratio of 1:1:1. Using a 1:1:1 fertiliser, for example a 15-15-15 (15% each of N-P-K) will result in low quality turfgrass, as the ratio of nitrogen to the other macronutrients is too low. Always use a 'turfgrass fertiliser', i.e. one designed specifically for turfgrass use, or alternately, supplement 15-15-15 with a nitrogen source such as urea.

Fertiliser rates for turfgrasses are keyed to the annual nitrogen requirement. As long as a turfgrass fertiliser with proper ratio of 4:1:2 is used, the other macronutrients should be supplied in correct amounts. However, there are special circumstances where a specific soil may bind a nutrient, making it unavailable. In this case, a soil test will alert the manager to supplement the normal fertilisation regime. Fertiliser rate will vary depending on a number of factors, including turfgrass species, rootzone type, climate (especially rainfall and temperature), amount of foot traffic, and expected quality level. For example, factors which will increase fertilisation requirement include sand-based rootzones, high rainfall, high average temperatures and long growing seasons, and high foot traffic.

Table 1* lists fertility requirements (based on N) for the major tropical turfgrass species. A range is given, with lower values appropriate for low maintenance turfgrass, while higher values appropriate for high maintenance sports turf or event lawn usage.

Turfgrass	Nitrogen (N) Requirement[1] (kg N/100 square metres/month)			Fertiliser Amounts (for Parks turf)[2] (kg fertiliser/100 square metres/month)		
	Streetscapes	Parks	Event/Sports	Urea (47% N)	20:5:10 (20% N)	15:15:15(15% N)[3]
Axonopus compressus (Cowgrass)	0.1	0.2 - 0.3	0.4 - 0.5 (N.R.)[3]	0.4 - 0.6	1 - 1.5	1.3 - 2
Axonopus (Pearlgrass)	0.1	0.2	N.R.	0.4	1	1.3
Cynodon dactylon (common bermuda)	N.R.	0.3 - 0.4	0.5 - 0.7	0.6 - 0.8	1.5 - 2	2 - 2.7
Digitaria Didactyla (Serangoongrass)	0.1	0.2 - 0.3	0.4 - 0.5	0.4 - 0.6	1 - 1.5	1.3 - 2
Eremochloa ophiuroides (centipedegrass)	0.1	0.2 - 0.3	N.R.	0.4 - 0.6	1 - 1.5	1.3 - 2
Paspalum Vaginatum (seashore paspalum)	N.R.	0.3 - 0.4	0.5 - 0.6	0.6 - 0.8	1.5 - 2	2 - 2.7
Stenotaphrum secundatum (St. Augustinegrass)	0.1	0.2 - 0.3	N.R.	0.4 - 0.6	1 - 1.5	1.3 - 2
Zoysia Japonica (Japanese lawngrass)	N.R.	0.2 - 0.4	0.4 - 0.5	0.4 - 0.8	1 - 2	1.3 - 2.7
Zoysia matrella (Manilagrass)	N.R.	0.2 - 0.4	0.4 - 0.5	0.4 - 0.8	1 - 2	1.3 - 2.7
Zoysia Pacifica (mascarenegrass)	N.R.	0.2 - 0.4	0.4 - 0.5	0.4 - 0.8	1 - 2	1.3 - 2.7

[1]Fertility requirement for turfgrasses is given as nitrogen requirement. To obtain the right nutrient balance, a turf fertiliser with a ratio of 4:1:2 or 4:2:2 should be used.

[2]Examples of fertiliser amounts to apply for parks turf. Values are rounded to the nearest decimal.

[3]N.R: Not Recommended

Calculating Fertiliser Application Rate

Due to the high rainfall, high temperature tropical climate of Singapore, nutrients are readily leached from the soil profile. Therefore, frequent fertiliser application is needed to provide adequate fertility to the turf, while avoiding environmental contamination. Monthly fertiliser application is recommended for most fertiliser types. Though slow release turfgrass fertilisers are available, nutrient release here is much faster than in temperate climates. In general for Singapore, normal release fertilisers should be applied monthly, and slow release fertilisers applied every 2 –3 months.

Fertiliser analysis is given on the label as three numbers separated by dashes, for example "30-10-15", representing the percentage by weight of the 3 macronutrients nitrogen, phosphorous, and potassium. The first number is the percentage of actual nitrogen given as N, the second the percentage of phosphorous given as P_2O_5 , and the third the percentage of potassium given as K_2O.

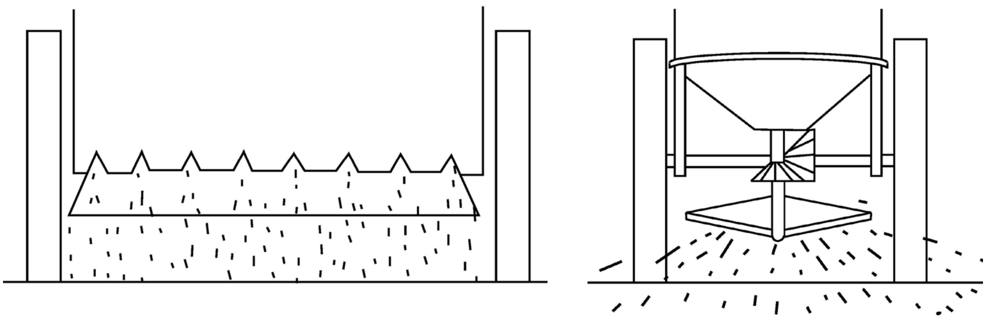
Since P_2O_5 is 44% P, and K_2O is 83% K, 1 kg of 30-10-15 fertiliser actually contains:

for N: 1 kg x 0.3 (30%) N = 0.3 kg N
for P: 1 kg x 0.1 P_2O_5 = 0.1 kg P_2O_5 x 0.44 P = 0.044 kg P
for K: 1 kg x 0.15 K_2O = 0.15 kg K_2O x 0.83 K = 0.125 kg K

To calculate the amount of fertiliser needed to apply a recommended rate, use the fertiliser analysis. For example, the recommended N rate for an *Axonopus compressus* (cowgrass) parks lawn is 0.2kg/N/100sq metres/month (Table 1). How much actual 30-10-15 fertiliser must we apply per monthly application?

0.2 kg N ÷ 0.30 (%N in fertiliser) = 0.7 kg fertiliser/100 sq metres/month

Calibrating Fertiliser Spreaders



Left to right: fig 4. Drop (a) and spin (b) spreaders for granular fertiliser application

For quality turfgrass, fertilisers must be properly applied using fertiliser spreaders. Fertiliser cannot be applied uniformly, or at the correct rate, by hand tossing. Solid fertilisers are generally applied as granules, by either drop or spin spreaders (Fig 4). Spreaders are inexpensive, and greatly improve both speed and accuracy of application. Drop spreaders apply a uniform band of fertiliser through an adjustible slit along the length of the fertiliser hopper. Therefore, when applying with a drop spreader there should be no overlap, and the application width should be the actual width of the hopper. In other words, fertiliser bands should just touch each other. In contrast, spin spreaders apply fertiliser by a spinning disk, with fertiliser being dropped onto the disk via an adjustible opening in the hopper. In this case, application distribution is in shape of a lens, with more being applied in the centre, and less at the edges. Therefore, when applying with a spin spreader there should be a 1/3 overlap between passes. For example, if the spreader throws fertiliser a total width of 2 metres, the distance between application passes should be 2 x 0.66 = 1.32 metres. For both spreaders, fertiliser rate (kg fertiliser/sq m) is controlled by the slit or hopper opening size and by the operator speed.

Calibration of fertiliser spreaders consists of applying the granules at several spreader settings, collecting and weighing these granules, and drawing a calibration curve.

The steps in calibration are listed below:

1. Lay out a rectangular canvas or tarp, approximately 5 metres long. Width of the canvas will depend on the type of spreader. For a drop spreader, canvas should be wider than the width of the hopper. For a spin spreader, canvas should be 2/3 the width of throw of the spreader. For example, if a spin spreader throws fertiliser 2 metres from edge to edge, canvas width should be 2 m x 0.66 = 1.32 m.

2. Fill the spreader with the granular fertiliser, set spreader on the initial setting, and run the spreader lengthwise down the centre of the canvas (Fig 5). Make sure that your walking or driving speed is identical to the speed used when actually applying the fertiliser, as rate will be affected by speed. For walk-behind spreaders, practice walking with the spreader until your walking speed is consistent.

3. Collect and weigh granules landing on the canvas.

4. Repeat steps 2-3 several times, using progressively higher spreader settings. For example, you may try settings 1, 2, 3, 4; or 1, 5, 10, 15, etc. Choose your settings to cover the range of scale present on the spreader.

Fig 5. Calibrating a drop fertiliser spreader

5. Calculate the collection area of the canvas. For the drop spreader, this will be canvas length times the hopper width. However, for the spin spreader, this will be the actual size of the canvas.

6. Convert granule weights from step 3 into weights/100 square metres. For example, if your collection area from step 5 is 10 square metres, and a collection weight from step 3 is 0.08 kg, then the converted weight for that spreader setting is: 0.08 kg x (100 sq m/10 sq m) = 0.8 kg/100 sq m.

7. Plot the converted granule weights from the 4 runs onto an x/y graph. Vertical axis will be kg fertiliser/100 sq m, and horizontal axis will be spreader setting. A proper calibration should result in a fairly straight line. The spreader is now calibrated for the particular fertiliser. Different fertiliser materials should be calibrated separately, as differences in size and density of the granules will affect application rate at a given spreader setting.

Calibrating Fertiliser Sprayers

Several steps are involved in calibrating sprayers, including a) checking sprayer nozzle uniformity, b) determining sprayer application volume in litres/100 square metres, and c) calculating the amount of fertiliser to put in sprayer tank.

a. Checking Sprayer Nozzle Uniformity

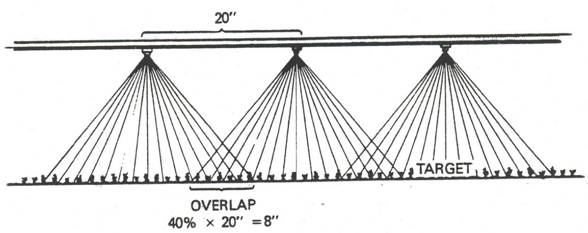


Fig 6. For uniform distribution, broadcast nozzles are designed for 40% overlap

The broadcast application method is used for all liquid fertiliser and pesticide applications on turfgrass. The exeption is for spot applications of pesticides. A boom sprayer is required, either walk behind (hand-held, or roller boom), or tractor mounted. Broadcast nozzles are required, mounted at equidistant spacing along the boom. Nozzle spacing distance, as well as nozzle spray angle will determine proper boom height above the turfgrass. For uniform application, boom should be held at the correct height to provide a 40% overlap of spray of nozzles (Fig. 6). This is because broadcast nozzles produce a lens shaped spray distribution pattern.

Check the spray pattern of each individual nozzle by spraying a dry concrete surface with pure water. If held at proper height, you should see a uniform, unbroken spray pattern along the concrete. Next, observe the nozzles directly during spray. Uniform cones of water should be visible, with no skips. Cone angle should be identical across nozzles on the boom. Nonuniform spray patterns indicate nozzle clogging. Finally, check the nozzle output uniformity. This can be done when you determine the sprayer application volume below.

b. Determining Sprayer Application Volume (litres/100 square metres)

Sprayer application volume is necessary to know prior to calculating the amount of fertiliser to put into the tank. The first step is to determine the time required to spray a given area. If a walk-behind sprayer is being used, practice your walk with sprayer until consistent. If a tractor mounted sprayer is being used, be sure to drive at the same speed during both calibration and application.

Mark off a distance of 10 metres, and walk or drive the sprayer across this 3 times. During each pass, time the number of seconds required to traverse the 10 metres, and calculate the average. Next, determine this area by multiplying the boom length by 10. For example, if your boom length is 1.5 metres, the area covered is 1.5 X 10 = 15 square metres.

Next, calculate the time required to cover 100 square metres. To do this, convert the time it takes to cover 15 square metres (above) to 100 square metres. For example, if it takes 9 seconds to cover 15 square metres, then:

9 seconds/15 square metres = x seconds/100 square metres x = 60 seconds

Now we can determine the sprayer application volume (litres/100 square metres). Fill sprayer with water, place a jar under each nozzle, and spray for 60 seconds. Measure the volume of each jar. Total volume will be sprayer application volume in litres/100 square metres. This data should also be used to check nozzle output uniformity. All nozzles should have the same output; if any deviates by more than 10% of the mean, it should be replaced, as it is either clogged or worn.

An example of the procedure is given below:
Sprayer is run for 60 seconds, and nozzle outputs are:

Nozzle 1 = 0.75 litres
Nozzle 2 = 0.80 litres
Nozzle 3 = 0.72 litres
Nozzle 4 = 0.73 litres

First, check for nozzle uniformity: Nozzle average is (.75+.80+.72+.73)/4= .75

Nozzle 1: .75/.75 x 100 = 0% of mean – O.K.
Nozzle 2: .80/.75 x 100 = 107% of mean – O.K.
Nozzle 3: .72/.75 x 100 = 96% of mean – O.K.
Nozzle 4: .73/.75 x 100 = 97% of mean – O.K.

Next, calculate the sprayer application volume:

.75+.80+.72+.73 = 3.0 litres/100 square metres

c. Calculating Amount of Fertiliser to Put in Sprayer Tank

Finally, we must calculate the amount of fertiliser to put in the sprayer tank. An example is given below:

1. You wish to fertilise a low maintenance *Axonopus compressus* (cowgrass) lawn. The fertility requirement (see above) is 2 – 3 kg N/100 square metres/year. Monthly fertilisation will require 3 ÷ 12 = 0.25 kg N/100 square metres/month.

2. As sprayer output is 3 litres/100 square metres, each litre of tank mix must contain 0.25 kg N 3 = 0.083 kg N. Your sprayer tank volume is 400 litres. Therefore, in a full tank you will need: .083 x 400 litres = 33.3 kg N.

3. Reading the fertiliser label, each litre of liquid fertiliser provides 0.3 kg N. Therefore, in a full tank you must add: 33.3 kg N x (1 litre/0.3 kg N) = 111.1 litres fertiliser.

4. Sometimes the fertiliser label gives the amount of N on a percentage weight basis only. In this case, you will need to weigh a litre of the fertiliser, and calculate the kg of N per liter fertiliser. For example, if the fertiliser contains 20% by weight N, and 1 litre of fertiliser weighs 1 kg, then 1 kg of fertiliser contains 1 x .2 = 0.2 kg N.

Proper fertilisation is one of the critical factors required for quality turfgrass. Fertiliser calculations and spreader or spreader calibrations are relatively easy, following common sense principles. Without proper calibration on a regular basis, it is impossible to apply the correct amount of fertiliser to turfgrass.