RESOURCE
CONSERVATION DISTRICT
OF SANTA CRUZ COUNTY

SOP: #RCDSCC-1
Version: 120621-2
Title: Soil Nitrate-Nitrogen (NO_3-N) Quick Test
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A. Purpose and Applicability

Soil Nitrate-Nitrogen (NO_3-N) Quick Tests help determine soil fertility levels. Knowledge of soil NO_3-N guides nutrient management decisions to increase yields and decrease production costs. If there is residual NO_3-N in agricultural soil, nutrient management practices may be adjusted to decrease potential leaching of NO_3-N into groundwater or NO_3-N runoff into surface water. At the beginning of the growing season existing sources of NO_3-N may be from residuals from a previous rotation, pre-plant applications, or mineralization. A pre-plant NO_3-N test may guide N application and provide a baseline for the field. Throughout the growing season NO_3-N may be monitored before sidedressing crops and as a monitoring component of a nutrient management plan. Post-harvest, residual NO_3-N may be measured to determine if the crops utilized the applied N and if there is excess NO_3-N remaining in the soil. Soil Nitrate-Nitrogen quick tests used in conjunction with soil moisture monitoring will provide data necessary to calculate a mass balance of NO_3-N. Surplus NO_3-N is an indicator of potential N leaching to groundwater. Groundwater discharge monitoring, including groundwater quality of the vadose zone, is an alternative listed in the Ag-Order for the Tier 2 and Tier 3 farms with high nitrate loading risk. The calculation of a NO_3-N mass balance, nutrient management and low-residual post-harvest NO_3-N are practices and targets for the Conservation Incentives program.

B. Summary of Method Page

Soil samples are collected that are representative of the field. Each sampled area should have similar slope, drainage and soil characteristics (color and texture). If there are a various soil types and field conditions, each is tested separately. The soil samples from one soil type within a field are mixed together and then added to a calcium chloride solution. The calcium chloride flocculates the soil and the NO_3-N from the soil is tested in the resulting solution. A Nitrate-Nitrogen Quick Test strip is used to determine the NO_3 value (ppm) for the solution. The NO_3 value is corrected for soil type and soil moisture. The corrected NO_3 value is the NO_3-N (ppm) for dry soil. A replicate is conducted to minimize sample variability.

C. Definitions

NO_3-N (Nitrate-Nitrogen): NO_3 (Nitrate) is an inorganic compound composed of one nitrogen atom and three oxygen atoms. NO_3-N (Nitrate-Nitrogen) indicates a measurement of the nitrogen within the nitrate, not including the oxygen atoms. The EPA drinking water standard is reported as NO_3-N (10 ppm). To convert NO_3-N to NO_3 multiply the NO_3-N value by 4.43.

ppm (parts per million): Ratio between the mass of the component and the mass of the solution (mg/kg). PPM may also be expressed as the ratio between the mass of the component and volume of the solution (mg/L) because one liter of water approximately equals one kilogram. 1 ppm = 1 mg/kg = 1 mg/L

Flocculate (v): To form aggregated or compound masses of particles.

Leach (v): To dissolve out soluble constituents by percolation of water.

D. Health and Safety Warnings

Material Data Safety Sheet: Calcium Chloride
http://fscimage.fishersci.com/msds/03900.htm

E. Cautions

1. Soil samples must be carefully collected to make sure they are representative.
2. The NO_3-N measurement for dry soil does not include NH_4-N. NH_4-N is usually quickly converted to NO_3, but in some cases, especially in the colder times of year, then N in NH_4 will not be measured using this method.
3. The results of the quick tests are usually categorized into three groups: N deficient, N sufficient and N excess. Laboratory analysis of nitrogen levels provides the most accurate measurement of N concentrations.

F. Interferences

Heat and sunlight may affect the test strips. Store the strips in a cool, dry location and replace the cap immediately after use. Do not use brass or galvanized tools for sampling because they could contaminate the samples with micronutrients. Use clean sampling tools and buckets that have not been stored near fertilizers.

G. Personnel Qualifications

To be determined

H. Equipment and Supplies

- Two 50 mL centrifuge tubes with 10 mL graduation marks or any volumetrically marked tubes with caps made out of nalgene, polyethylene, or some other inert material (or 3 replicates?)
- Two large clean buckets: one that holds at least a gallon (if making the Calcium Chloride solution) and the other large enough for the soil samples.
- 1 gallon distilled water
- 5.6 grams Calcium Chloride (or 0.01 molar Calcium Chloride solution) (should we specify CaCl dehydrate or certified reagent grade?)
- Nitrate Test Strips (need to decide on brand and range)
- Soil Sampler/Probe (brand/size/type?)
- Watch/Stop watch

I. Procedural Steps

1. Each sampling area should have similar slope, drainage and soil characteristics (color and texture) and should not exceed 40 irrigated acres or 100 dry acres. Within the uniform field area, samples should be collected randomly from all regions of the field (each side and several in

the middle). Exclude small areas that are obviously different (knolls, low points) or analyze the dissimilar portion as a separate sampling area.

2. Collect 15-20 samples from the uniform field area. Do not collect the top two inches of soil because it may have high levels of NO_3-N and may be too dry for active root growth. Angle the soil probe in the direction of the fertilizer bead or drip tape (Attachment 1). Do not sample through a fertilizer band. Use a soil probe to collect sample soil cores up to 12 inches deep. The goal is to collect the soil sample from the active root zone. For shallow rooted crops a 6 inch deep sample soil core is sufficient.
3. Thoroughly mix the (15-20) soil samples in a clean bucket until there is a granular soil mix. Clay soils may be difficult to mix so a smaller subsample may be used. In the case of clay soils, lay out the sample cores on a tarp. Pinch small uniform amounts of soil from the sample along the length of each soil core. Thoroughly mix the "pinched" off subsamples together in the bucket.
4. In another clean bucket create the extracting solution. Add 5.6 grams of Calcium Chloride to 1 gallon of distilled water to create a 0.01 molar Calcium Chloride solution.
5. Fill the graduated tube with 30 mL of 0.01 molar Calcium Chloride solution.
6. Add soil sample to tube until the solution level rises to 40 mL.
7. Cap the tube and shake vigorously until all soils are dispersed and clods are dissolved.
8. Wait for the soil particles to settle and for the solution at the top to be reasonably clear. This may take a few minutes for sandy soils and up to an hour for clay soils.
9. Use a new nitrate strip for each sample. Dip the nitrate test strip into the sample solution for one second, gently shake off excess liquid and wait 60 seconds. Compare the color of the test strip to the color chart provided with the test strips. The used test strips will darken over time, so conduct color comparison immediately after 60 seconds have passed.
10. Each color represents an NO_3 level (ppm or mg/L). If the color of the test strip is between two colors on the color chart, interpolate the NO_3 level on the strip to the closest color on the chart.
11. Repeat steps 4-10 for each replicate.

J. Data Interpretation

1. If the Nitrate Test Strips report NO_3-N then multiply by 4.43 to get NO_3.
2. The NO_3 value needs to be corrected for soil texture and moisture and then converted to NO_3-N for dry soil. Divide the NO_3 number from the test strip by the correction factor to get corrected NO_3-N (Strip Reading NO_3 ÷ Correction Factor = ppm NO_3-N dry soil).

Correction Factor		
Soil Texture	Moist Soil	Dry Soil
Sand	2.3	2.6
Loam	2	2.4
Clay	1.7	2.2

Example: 10 ppm NO_3 from test strip from a moist sandy field: 10 NO_3 ÷ 2.3 = 4.4 ppm NO_3-N

3. To convert NO_3-N ppm to NO_3-N lbs/acre multiply the NO_3-N ppm value by 2 for 6" samples or 4 for 12" samples. Note: 1 acre of 6" deep soil is considered to weigh 2 million pounds.

K. Data and Records Management

To be developed with individual grower

L. Quality Assurance and Quality Control

EPA QAQC on soil sampling: http://www.epa.gov/esd/cmb/research/bs122.pdf
EPA SOP for QAQC samples: http://denr.sd.gov/des/gw/spills/Handbook/SOP6.pdf

M. References

Agriculture Water Quality Alliance. Soil Nitrate-Nitrogen Quick Test. Internet. [cited June 19 2012]. Available from: http://www.awqa.org/pubs/waterqual/soilnproced.pdf

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Hartz T.K. 2010. Using the Pre-Sidedressing Soil Nitrate 'Quick Test' to Guide N Fertilizer Management. Vegetable Research and Information Center. Internet [cited June 20 2012]. Available from: http://vric.ucdavis.edu/pdf/FERTILIZATION/fertilization&soil_Using%20the%20Pre-Sidedressing%20Soil%20Nitrate%20%E2%80%98Quick%20Test%E2%80%99%20to%20Guide%20N%20Fertilizer%20Management.pdf

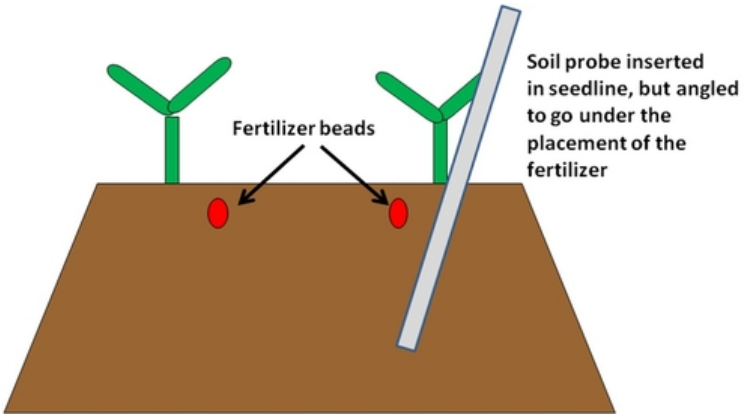
National Resource Conservation Service (NRCS). 2011. Sampling Soils for Nutrient Management. Internet [cited June 20 2012]. Available from: http://www.mt.nrcs.usda.gov/technical/ecs/agronomy/nutrient/soilsampling.html

Smith R. 2011. Details on the Nitrate Quick Test. Internet [cited June 20 2012]. Available from: http://ucanr.org/blogs/SalinasValleyAgriculture/index.cfm?tagname=Nitrogen%20management

Smith R. Cahn M. 2012. Nitrate to Nitrogen Conversion and Estimating N Contribution from Irrigation Waters Containing Nitrate. Internet [cited June 21 2012]. Available from: http://ucanr.org/blogs/SalinasValleyAgriculture/index.cfm?tagname=Nitrogen%20management

N. Attachments/Checklists

1.



Angle the soil probe in the direction of the fertilizer bead or drip tape. Insert the probe in the seedline, and angle it to go beneath the bead of fertilizer or beneath the drip tape. For consistency, sample the soil at an angle even in fertilizer beads or drip tape are not present (Smith 2011). Image is from Smith (2011).

O. Supplies

Calcium Chloride Dihydrate:
https://new.fishersci.com/ecomm/servlet/fsproductdetail?aid=24969&&storeId=10652

Nitrate Test Strips:
Ben Meadows $57.90 0-500 ppm NO_3 : http://www.benmeadows.com/em-quant-10-500-ppm-nitrate-test-strips-pkg-of-100_s_7830/?searchterm=7830
Graduation 0-10-25-100-250-500 ppm
Nitrate is reduced to nitrite by a reducing agent. In the presence of an acidic buffer, the nitrite is converted to nitrous acid which diazotizes an aromatic amine, this coupled with N-(1-naphthyl) ethylenediamine to form a red-violet azo dye.

Hach $18.35 0-50 ppm NO_3-N: http://www.hach.com/nitrate-and-nitrite-test-strips/product-details?id=7640211606&callback=qs
Graduation 0-1-2-5-10-20-50 ppm
To convert nitrate - N to nitrate multiply the value read from the strip by 4.43.

Soil Probe $98 Stainless Steel: http://www.benmeadows.com/oakfield-model-l-tube-type-soil-sampler_s_220106/?searchterm=220106