A collaboration between:

Sampling for Soil Nitrate Determination

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Time of sampling

- Soil samples for nitrate analysis are either collected near planting time (generally called pre-plant nitrate test; PPNT), or just before the main N application is due (pre-sidedress nitrate test; PSNT). In both cases, samples should be taken at least 3 weeks after the last nitrogen (N) application.

Taking a representative sample

- When soil properties (e.g. texture), plant development, or yield potential differ within a field, the field should be divided into different management areas with similar characteristics and a separate sample from each area should be taken [8].
- A convenient way to check for differences in soil properties is to use the interactive application SoilWeb (available at http://casoilresource.lawr.ucdavis.edu/soilweb/). For figure 1, the application was used for a field near Davis, CA. For this field, separate samples should be taken from the area with Brentwood silty clay loam (BrA) and from the area with Myers loam (Ms). The central and right section of the field should be sampled separately if their management differs.
- If it is not clear whether textural changes or differences in the crop history are pronounced enough to affect nutrient availability, it is a good idea to sample the different areas separately. If the soil analyses indicate that the areas are similar, they can be treated as one management area for future sampling.
- Crop management may lead to differences in nutrient availability within a field over time. For example the application of lagoon water with flood or furrow irrigation may result in differences between the top and the bottom of the field. Leveling of fields may also cause differences between areas were topsoil was removed and areas where soil was relocated. These areas should be sampled separately. If the soil analyses show no difference, they can be sampled together in the future.

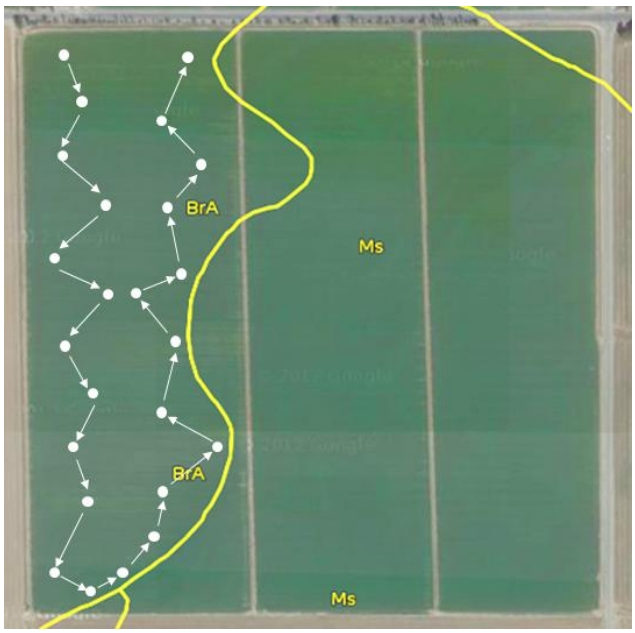

Figure 1: Soil sampling plan for a representative sample from a field or management area. The Picture is a screenshot of a field from Google map using the SoilWeb application.

Sampling procedure

- The soil nitrate content is often spatially variable. For this reason, a minimum of 20 cores should be taken and composited to represent a field or management area [8].
- While the pre-plant nitrate test is generally taken to a depth of one to four feet, depending on the rooting depth of the crop, the pre-sidedress nitrate test is most often taken from the top foot or two of the profile [1, 3, 4] (see the fertilization guidelines for crop-specific information about sampling depth).
- Cores are taken with a sampling probe or auger from the entire area of the field or management area by walking a zigzag course around or through the area (Figure 1).
- Do not sample where fertilizer has been applied recently, do not sample unusual areas, such as corners, edges of former fields or fence rows that are now in the field.
- Remove crop residues on the soil surface before taking a core [5].
- Collect the cores in a clean plastic bucket to create a composite sample [8].

Sample handling

- When all the cores for a management area are taken, mix them thoroughly in the plastic bucket.
- In soil samples that are moist and warm, microbial activity continues to produce nitrate after the cores are taken. In order to prevent overestimation of the soil nitrate content, samples need to be either kept cool and sent to the laboratory immediately or quickly air-dried [5]. To dry samples, spread the soil in a thin layer on a sheet of plastic and dry it in the sun or under a fan. Storing and dying soils in paper bags is not advised since the paper will absorb nitrate, leading to an underestimation of the soil nitrate content.
- The dried sample is placed into a plastic bag, which is labeled clearly. Approximately 1 pint (500 mL) of soil is required for routine analyses. If there are any questions, follow the instructions of the soil test laboratory for sample preparation and submission.
- Test strips for on-farm nitrate determination are an alternative to laboratory analyses. Descriptions of the procedure are available online [2, 6, 7].

Interpreting soil nitrate levels

- The soil nitrate test is a measure of the amount of nitrate present in the rooting zone early in the growing season. Nitrate can be taken up directly by plants. The amount of nitrate-N in the rooting zone is therefore directly available to crops. In the absence of excessive rainfall or irrigation water application between the time of sampling and the crop stage of major N uptake, the soil nitrate-N can be subtracted from the recommended N fertilization rate.
- Nitrate is very mobile in soil. Heavy rainfall or application of excess irrigation water after taking soil samples may leach nitrate below the rooting zone or result in denitrification losses, making the N unavailable for the crops [5]. Under these conditions, the soil nitrate test will overestimate the nitrate-N available.
- The nitrate test measures the amount of nitrate available at the time of sampling. The soil nitrate test is not a measure for the amount of N that will be made available by microbial activity during the cropping season. During the growing season, soil microorganisms mineralize soil organic

material, constantly replenishing the pool of available N.

- A soil nitrate sample taken during crop establishment will include more N from mineralization than a pre-plant sample. In addition, later sampling reduces the risk that some of the nitrate measured is lost before the crop can take it up. Therefore, samples taken during crop establishment more accurately estimates the available soil N than pre-plant samples [5].
- When crop residues with a low N concentration (high carbon to N ratio), such as straw or corn stover are incorporated, microorganisms may immobilize N from the soil solution, reducing the amount available to crops. In contrast, the incorporation of N rich residues (low carbon to N ratio), such as legumes, may result in the mineralization of large amounts of N. Soil nitrate samples taken just before residue incorporation or during the weeks following their incorporation may therefore lead to incorrect assessments of the N available to crops.
- Irrigation water may contain considerable amounts of nitrate, especially when groundwater is used. For an accurate determination of the fertilizer N needs, soil nitrate as well as nitrate in the irrigation water should be taken into account.

Nitrate or nitrate-N

When nitrate is measured, the result may be expressed in units of nitrate or nitrate-N (e.g. ppm, mg/L, or lbs/acre). What is the difference between the two?

Nitrate (NO_3^-) contains both N and oxygen, its molecular weight being 62 g/mole. The term nitrate-N refers only to the N portion of the nitrate molecule, which account for 14 of the 62 g/mole, the rest being oxygen. Therefore, to convert nitrate to nitrate-N, the concentration of nitrate needs to be divided by 62 and multiplied by 14:

Nitrate-N = Nitrate / 62 x 14

Crop requirements are generally expressed in lbs N/acre. To determine the amount of N fertilizer needed to meet the crops' demand, the concentration of nitrate-N (and not nitrate) in the rooting zone is being subtracted from the N requirement of the crop.

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This document is available online at https://apps1.cdfa.ca.gov/FertilizerResearch/docs/Soil_Sampling_Nitrate.pdf

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