



Soil Sampling for Agronomic Manure Management

This guide is adapted from a similar bulletin available from the California Dairy Quality Assurance Program (see Pettygrove and Campbell Mathews, 2008 in references) but addresses soil sampling for agronomic, rather than regulatory, purposes.

Soil testing can help farmers avoid unnecessary fertilizer purchases and manure applications, decrease incidence of crop nutrient deficiencies, detect salinity or pH problems, and reduce the potential for nutrient excesses that contribute to groundwater contamination. In some dairy forage fields in California, soil test P and K levels are as much as 10 times the published critical deficiency values. Soil testing will provide critical information to producers who are phasing in improved nutrient management procedures.

Soil sampling planning

Soil sampling may be carried out by farm personnel, or it may be part of a crop management package provided by a fertilizer retailer, an analytical laboratory, or an independent crop consultant. Regardless of who collects samples, individuals with specialized knowledge such as a Certified Crop Adviser should review with the farmer when, where, and how soil sampling is to be conducted and which specific soil tests are appropriate.

Which soil tests should be conducted? (See Q&A section below and table)

Selection of soil tests should be based on specific agronomic objectives as well as on regulatory requirements. Currently, dairy waste discharge requirements in the Central Valley (Order No. R5-2007-0035) require testing soil for total P in fields every five years. Other tests are recommended though not required.

For routine nutrient evaluation in established alfalfa fields, plant sampling, rather than soil testing is recommended.

Sampling Considerations

1. Sampling Pattern: Work with your crop consultant/adviser to decide how to delineate sampling zones within fields. These sampling zones could consist of areas that have similar soil texture, crop yield, or manure application history and may exclude small areas of different texture, drainage, etc. Over time, the results of sampling “by zone” will provide a far more useful record of the impact of farming practices on soil fertility than a composite sample of a large heterogeneous field.
2. Recordkeeping: Develop a consistent method for labeling soil samples so that there will be no future confusion on location of sampling zones, sampling depth, etc. Incorporate soil sampling and analysis information into your regular crop production records for each field. Some crop management professionals mark sampling benchmark sites or zone boundaries with GPS/GIS.

3. **Soil Sampling Tools:** Sampling supplies and equipment include a push-type soil sampling probe, a bucket style auger (for gravelly or claypan soils), permanent marker pens, plastic bags, chain of custody form, notebook, field map, dishpan or bucket for subsampling.

Sample Collection

1. Label sample bag with field identification (consistent with identification used in the Nutrient Management Plan), sampling zone, sampler's name, the date and time of sampling, depth of sampling.
2. Using a soil probe (push tube) or bucket style auger (sometimes needed for gravelly soils) collect needed number of soil cores from each sampling zone and place together in a bucket or dishpan. Shovels should usually not be used for sample collection as they do not allow for the collection of a uniform representation of the sampled depth.
3. A composite sample consisting of 10-30 cores should be collected for each sampling zone. Avoid fertilizer bands, dairy lagoon water solids/crusts, and pieces of corral manure or crop residue. Thoroughly crumble and mix in a plastic bucket or dishpan and save about one pint in a sample bag for submittal to the laboratory. The number of cores included in the composite will depend on the size and variability of the sampling zone as well as the analyses needed. Generally, more cores are needed for nitrate, fewer for pH, P and K.
4. Thoroughly crumble and mix material in the bucket or dishpan.
5. Remove a 1 pint subsample and place in sample bag for submittal to the laboratory.
6. Preserve sample as needed. For nitrate analysis, either dry samples immediately (maximum 120 F) or keep refrigerated.
7. Complete a chain of custody form if samples are to be used for complying with regulatory requirements.
8. Deliver to laboratory as soon as possible.
9. Keep a copy of chain of custody form and records on sample collection & sample identification

Questions and Answers

Question 1: At the beginning of the crop season, what is the quantity of plant nutrients available in the soil for crop use?

For available nitrogen, use a pre-plant soil nitrate test. The sample should be taken after any pre-irrigation (which may leach nitrate out of the root zone), and before any pre-plant applications of manure or fertilizer N. Evaluation of phosphorus, potassium and other nutrients can be done at this time, but soil testing for those nutrients is often carried out at other times of the year (fall) and is not normally conducted annually unless crop deficiency is suspected.

Question 2: How much soil organic N will become available to plants during the current season due to decomposition (i.e., mineralization) of crop residues and residual manure applied in past years?

There is currently no established soil test to help answer this critical question. A method that can be considered is to monitor crop growth and yield for a season on check plots or strips from which N fertilizer and manure have been excluded.

Question 3: How much available N remains from applications of fertilizer or manure made just prior to planting or during the early part of the season?

A soil nitrate test conducted one or more times during the season will provide a rough estimate and may be helpful in deciding whether additional mid-season applications can be delayed or

avoided completely. Heavy leaching due to excessive irrigation or heavy rains reduces the value of this test. Soil nitrate is often more spatially variable than pH or other nutrients, and it may take a large number of samples to provide a reliable picture. Soil analysis should include ammonium, as well as nitrate, if samples are taken less than two weeks after dairy lagoon water is applied.

Question 4: How well did application of manure and fertilizer match crop N requirements during the past season?

Deep sampling (to 36 inches or more) for nitrate at or shortly after harvest of summer annual crops can reveal whether the nitrogen program was on target or excessive. As with mid-season soil nitrate testing, over-irrigation and significant leaching will greatly reduce the value of this test.

For Further Information

Western Fertilizer Handbook, 9th edition. 2002. California Plant Health Association. Sacramento, CA.

Pettygrove, S. and M. Campbell Mathews. 2008. Soil sampling protocol. Tab 5.4 WDR General Reference Binder Materials. California Dairy Quality Assurance Program. <http://www.cdqa.org> (verified April 2010).

Soil and Plant Analysis Council. 1999. Soil analysis handbook of reference methods. CRC Press. Boca Raton FL

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Type of test	Purpose	Limitations	Frequency	Time of year	Depth of sampling
Pre-plant nitrate	RECOMMENDED under dairy WDRs. Assess currently available N from planting through early season	Not useful where leaching is excessive, typically in sandier soils. Not calibrated for California, but can provide rough assessment	Annually or (for double crop) semi-annually	After pre-irrigation and before any pre-plant manure or N fertilizer application	0-2 ft or deeper
Post-plant nitrate (in other states called PSNT - "Pre-sidedress Nitrate Test")	Assess currently plant-available N through mid-season. May be useful to confirm nutrient budget.	Not useful where leaching is excessive, typically in sandier soils; not calibrated for California, but can provide rough assessment	One or more times per season	Post-emergence through mid-season	0-1 ft or deeper
Post-harvest (or shortly before harvest) nitrate	RECOMMENDED under WDRs. Retrospective evaluation of mid- to late-season N program	Not useful where leaching is excessive in mid- to late-season.	Audit basis every 3 years on selected fields	From just before to a few weeks after harvest of summer annual crops	0-3 ft or deeper in 1 ft increments
Soil Total N or Soil Organic Matter	Indicator of seasonal mineralizable N in soil	Rough indicator. Not well related to the "active" fraction of soil organic N. Interpretation based on small amount of UC research.	Suggest every 3 years	Suggest fall, prior to any manure applications	Suggest 0-1 ft
Soil alkaline extractable N (UC modification of Illinois amino sugar test)	Indicator of seasonal mineralizable N in soil	Same limitations as total N but in research showed somewhat better relationship to mineralizable N. Not sensitive to recent manure applications	Suggest every 3 years	Suggest fall	Suggest 0-1 ft
Total P (analytical method, sampling depth not specified by Regional Board)	REQUIRED under WDRs May be used by Regional Board to evaluate potential for P transport to water. Interpretation is not clear at this time	Method for interpretation not known. Studies show that soil total P is not a sensitive or accurate indicator of risk of P release from soil.	Every 5 years, beginning in 2008	Not specified in WDR. Note WDR does specify minimum number of samples per area.	Suggest 0-1 ft
Soil test P ("Olsen P" or "Bicarbonate P" is common in the arid and semi-arid USA)	(1) Assess adequacy of soil P levels for plant growth. (2) Assess potential for excessive soluble P level, e.g. where there is potential for transport to surface waters.	Not well calibrated for heavily manured fields.	At least every 3 years or when problem occurs	Suggest fall, prior to any manure application	0-1 ft
Soil test K ("Exchangeable K")	(1) Assess adequacy of soil K levels for plant growth; (2) Assess potential for excessive K uptake by forages (RECOMMENDED under WDRs).	No California data relating level to potential for excessive K uptake by forages	Every 3 years or when problem occurs	Suggest fall, prior to any manure application	0-1 ft

WDR = Order No. R5-2007-0035. Waste Discharge Requirements General Order for Existing Milk Cow Dairies. California Regional Water Control Board Central Valley Region