# Soil Sampling for Nutrient Management

## Nutrient Management Factsheet – No. 2 in Series

Revised September 2010 – Order Reference No. 631-500-1

For nutrient management, soil sampling is done to collect a soil sample that represents the spatial area for which nutrient information (e.g. fertilizer recommendations) is needed. To do this many samples will be collected and mixed together to make one composite sample for each field. Any soil sample can be analyzed to give lab results but results are meaningful only if appropriate sampling and handling procedures are used. The results are used to help determine what level of additional nutrients, if any, are required.

Soil testing can be done for different purposes and the purpose affects the sampling depth and time of sampling among other considerations (**Table 1**). To use the Nutrient Management Planning (NMP) software produced for the Canada-BC Environmental Farm Plan program, soil samples should be taken for nitrogen, phosphorus and potassium for agronomic purposes. These elements are the focus of this factsheet.

**Table 1**. Recommended depths and times for sampling soil phosphorus, potassium and nitrate-nitrogen.

| Component | Purpose | Phosphorus (P), Potassium (K) | Nitrate-Nitrogen ($NO_3$-N) |
|---|---|---|---|
| Time | Agronomic | | |
| | - predictive | Pre-plant ('before growing season') | Humid with moderate winters: post-harvest ('after growing season')<br>Dry with cold winters: pre-plant<br>Forage corn: pre-sidedress |
| | - feed-back | Post-harvest | Post-harvest |
| | Environmental | Post-harvest | Post-harvest |
| | Monitoring | Consistent: pre-plant or post-harvest | Consistent: pre-plant or post-harvest |
| | Trouble shooting | Variable (depends on issue) | Variable (depends on issue) |
| | Characterization | Variable (depends on issue) | Variable (depends on issue) |
| Depth | General | 0-15 cm (0-6") | 0-30 cm (0-12") |

## When to Collect Soil Samples

### Sampling frequency

Sample every field at least once every three years. Fields in perennial crops should be sampled before they are seeded or planted. Consider sampling more frequently if the soil is coarse-textured or if crops have been grown that are heavy users of nutrients, since nutrient and pH levels tend to change more frequently than in fine-textured soils.

More frequent sampling generates more data, making it easier to identify trends over time.

For soil nitrate-N, annual pre- and post-harvest testing is recommended for certain situations – see the *Feedback (agronomic) and environmental testing* section below.

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### Times of year

Check with the chosen lab about their turnaround time for soil analysis. Each type of sampling described below should occur at approximately the same time in each year of sampling to help distinguish seasonal and sampling variation from actual changes in soil nutrients.

### Predictive (agronomic) testing

This testing looks forward in time. The following times are recommended for samples that can be taken before or during the growing season (for which nutrient application decisions are being made):

Pre-plant sampling in the spring is recommended. Samples should be collected before starting field work for annual crops and before a new flush of growth begins for perennial crops. These are the only results used in the current NMP software. Nitrate values are expected to be small at this time in south coastal BC.

- Post-harvest nitrate values from the previous fall, after active crop growth has stopped or minimized, can be substituted for pre-plant nitrate values (i.e. results can be used in the current NMP software) for soils of the Interior of BC (dry with cold winters), but not for soils of the south coast of BC (humid with moderate winters).

The Pre-Sidedress Nitrate Test (PSNT) is used to determine corn's sidedress nitrogen requirements. Soil samples are collected at the 6-leaf stage (usually mid-June), just before the crop takes up nitrogen rapidly. Although not used in the current NMP software, the PSNT is typically more reliable as a predictive test than pre-plant nitrate testing and should be considered to be a part of nitrogen management for corn. For more information, see the reference below.

Zebarth, B.J. 2004. Spring nitrogen tests *in* S. Bittman and G. Kowalenko (eds). Advanced Silage Corn Management. Available at http://www.farmwest.com/index.cfm?method=library.showPage&librarypageid=127

### Feedback (agronomic) and environmental testing

This is testing that happens at the end of a growing season to help plan nutrient applications the next growing season. It is most useful for nitrogen when there is 1) a history of post-harvest nitrate results and related information (e.g. crop yield and quality, manure application rate and history, weather, etc.), and 2) the cropping in the field has and will be consistent (i.e. there is a perennial crop or the same annual crop grown will be grown). A post-harvest nitrate test and interpretations have been proposed for grass hay/silage and silage corn fields in south coastal British Columbia. For a full discussion of the use, interpretations and limitations of this test, see the following:

Sullivan, D.M and C.G. Cogger. 2003. Post-harvest soil nitrate testing for manured cropping systems west of the Cascades: available on the Oregon State University extension website at http://extension.oregonstate.edu/catalog

Very high post-harvest nitrate test values could indicate situations when nitrogen application rates could have been decreased or eliminated with low risk to the crop.

Post-harvest sampling is recommended for environmental testing because it examines the nutrients left in the soil after crop uptake and before the usual time of highest risk of transport into ground and surface waters. Nitrogen and phosphorus are the main nutrients of environmental concern.

### Sampling for other purposes

*Monitoring*: If tracking nutrient trends across years, be consistent with respect to time, location and depth of sampling.

*Troubleshooting or Characterization*: If sampling to troubleshoot suspected nutrient-related problems or to complete a soil description, sampling times vary according to the specific issue and objectives of sampling.

## Sampling Depth

### Phosphorus, potassium (and ammonium-nitrogen)

The recommended sampling depth is 15 cm deep (6"). Most of the phosphorus and potassium are likely at this depth. Although cultivation can be variable, 0-15 cm will include the most common minimum of a mix layer. Soil nutrient test interpretations for British Columbia soils have been based on this sample depth.

### Nitrate-nitrogen

The recommended sampling depth is 30 cm (12"). Note the approximate sample depth if you must sample at shallower depths. Plants usually root deeper than 15 cm and nitrate will move with water down the soil profile, so it is important to sample deeper than for phosphorus and potassium.

*Tips for sample collection*

Soil samples collected in perennial forage crops will have a layer of sod on top of the soil. Discard the top layer of dead leaves and roots above the mineral soil but not the roots that extend into the soil.

When sampling in newly worked bare land, gently press down the soil with your boot before sampling to more accurately mimic the settled soil depth.

## Where to Sample

The objective is to ensure that a soil sample represents the area for which nutrient information is needed. Location of sampling is more important for phosphorus and potassium (and ammonium) than for nitrate; over time, the banding effect of nitrogen fertilizer will decrease.

Before soil sampling, consider the variability within each field. There may be variability due to differences in manure or fertilization history, topography, drainage, eroded areas, sandy vs. clay-rich areas, or sections of a field that have previously been farmed separately over the years.

Unusual areas should be avoided for routine sampling or they should be sampled separately. These include small, low, wet areas; dead furrows; areas close to trees, roads and fences; manure piles; fertilizer storage; and livestock droppings.

Use the information about the variability across your fields to create a field management map. Group sections that will be managed uniformly (i.e. fertilizer spread at a constant rate) into a sampling unit. Sampling units should be no more than 10 hectares (25 acres) or they can be larger if the characteristics and management of the field is known to be uniform. Assign a number or name to each sampling unit. Keep the same sampling units after the first year of sampling unless fields will be split. Record all pertinent information about the areas sampled. This information should include cropping history and desired crops to be grown, recent fertilizer or soil amendment applications, livestock use and any other relevant information about the site.

**Where nutrients are broadcast (applied uniformly)**

In each field or sampling unit, samples should be collected using a random or zig-zag pattern. **Figure 1** shows an example of a random soil sampling pattern (shown in yellow) and areas to avoid (shown in pink).

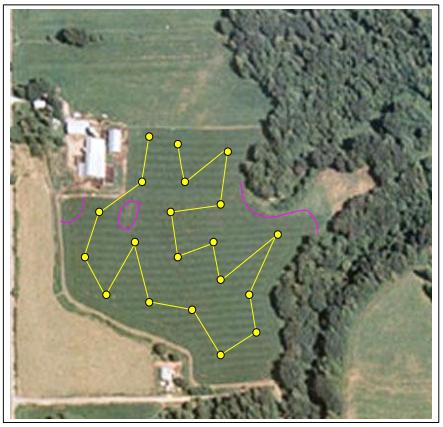

**Figure 1.** Random soil sampling pattern

**Where nutrients are applied in bands**

Sampling methods from the post-harvest phase of the Fraser Valley Soil Nutrient Study 2005 and Okanagan Agricultural Soil Study 2007 are described below. These methods can be adapted for agronomic soil testing. Ultimately, you may choose a specific sampling method for which you have most historical data for the fields being sampled.

The Fraser Valley Soil Nutrient Study 2005 and Okanagan Agricultural Soil Study 2007 reports are available at, http://www.agf.gov.bc.ca/resmgmt/EnviroFarmPlanning

Corn: If the location of the phosphorus fertilizer band is known, take samples at random locations between the fertilizer bands. If the location of the fertilizer band is unknown, take 30 to 40 cores per field from random locations or about twice as many as cores as for fields without fertilizer bands.

Raspberries: take pairs of samples (1) and (2) (**Figure 2**):

1) the centre of the fertilizer band between the plants along the crop row
2) the centre of the cultivation/root mound between plants in the crop row

Blueberries: take pairs of samples (1) and (2) (**Figure 3**):

1) small plants - outside the drip line OR
1) large plants - midway between plants in the row
2) base of raised bed between plants and inter-row

Tree Fruits and Grapes: take samples at random locations from within the drip line of the tree or vines.

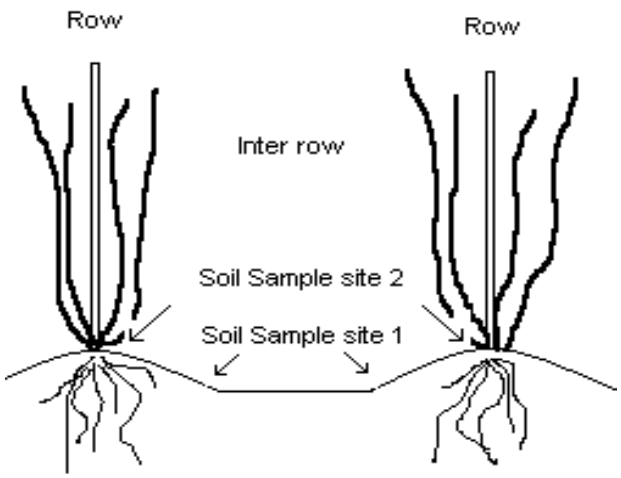


**Figure 2.** Sampling locations for raspberries

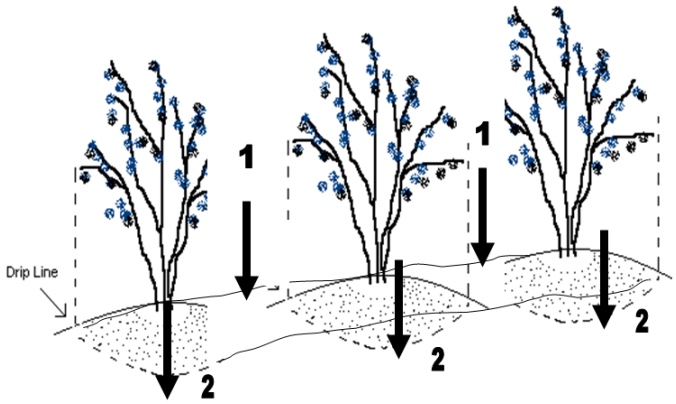


**Figure 3.** Sampling locations for blueberries

## Sampling Equipment

A soil sampling probe (tube) or auger is recommended. A soil probe (**Figure 4**) works best in well cultivated soils without rocks but is difficult to use in rocky, very dry or very wet soil. An auger is better for less well cultivated or rocky soils.

If the soil texture is very coarse or there are many coarse fragments, a shovel can be used instead of a soil sampling tube or auger. When sampling with a shovel, make a V-shaped hole where the sample is to be taken. Take a 2-3 cm (1 inch) thick slice down one side of the hole to 15 cm (6"), and trim the slice to form a 2-3 cm (1 inch) wide core (**Figure 5**). Lift out the soil slice and place it into the sample bucket.

**Figure 4.** Soil probe

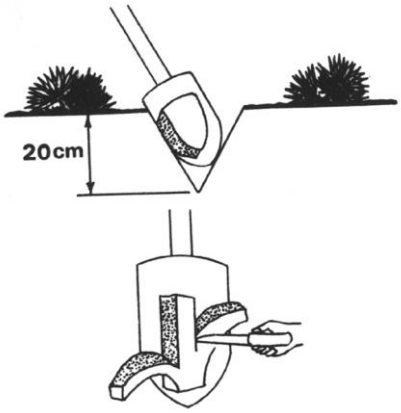


**Figure 5.** Shovel method of soil sampling

Ensure that the sampling equipment is clean. If sampling for micronutrients or metals, ensure there is no rust on it to prevent contamination. Latex gloves will prevent contamination from hands. A plastic bucket or clean bag in a bucket would be ideal to hold soil samples in the field.

## Sample Handling

Composite samples are the mixtures of numerous individual samples that will represent a sampling area. To make a composite sample, collect at least 15 soil cores (or slices) in each sampling area. The recommended maximum area is 10 hectares (25 acres) per 15 cores. Place all cores in a clean plastic pail or container. About 0.5 kg (1 lb) is usually more than enough.

Then the sample must be mixed well and precautions need to be taken to minimize changes before lab analysis. There are two options to do this:

1) Keeping the soil cool (but not frozen)
This assumes the sample is dry enough to be mixed well. After mixing the composite sample well, fill a bag or other clean container with soil. Clearly label samples with the date, field or sample unit name, and sampling depth (0-15 cm or other). Keep the samples cool (e.g. refrigerated in a cooler but not frozen) until they reach the lab and they should reach the lab as quickly as possible. Freezing soil samples is not recommended as soil nitrogen can change forms while freezing/thawing.

2) Air drying the soil
Keep samples cool as described above until they can be spread on plastic sheets in a clean, ventilated room at room temperature. Dry thoroughly for one to two days, and then mix each sample well and send to the lab in clean and labelled containers.

Ideally, prepare samples for analysis after drying and before sending to the lab: crush the dried soil, screen (sieve) it and then mix it well. Then you can send part of a sample to the lab and save another part for your own reference sample, in clean and labelled containers.

A significant advantage of air drying before sending to the lab is the ability to save some reference samples, since the nutrients in air-dried soil samples will be stable for many years. Keeping some reference samples would be useful if you want to compare different labs' results or evaluate the analysis quality of a lab.

For a soil sample to be mixed thoroughly before it is analyzed, it is easiest to do this when the sample is dried first. Splitting a soil sample to send to different labs is not recommended unless it is first air-dried and mixed well.

## Lab Analyses to Request

To use the NMP software, the following soil test information is needed for a pre-plant soil sample taken in the spring:

- nitrate-nitrogen ($NO_3$-N)
- available phosphorus (P)
- available potassium (K)

In addition, ammonium-nitrogen ($NH_4$-N) is recommended.

To be able to better interpret lab results, find out the lab methods for soil test phosphorus and potassium. See Factsheets 1 and 3 in the Nutrient Management Factsheet Series for more information.

Commercial laboratories usually have soil fertility packages that will include the above analyses as well as other parameters including soil pH and other nutrients. Keep this information in your records.

To use the NMP software, the fertilizer recommendations on a lab report are not required.

## Questions and Answers

**1. Why is nitrate ($NO_3$) sampled differently from P and K?**

It has to do with the behaviour of the nutrients in terms of how prone each nutrient is to being moved through soil. Whereas P and K are relatively immobile, $NO_3$ is easily leached or moved through soil by water (rain or irrigation).

**2. Why does sampling time matter?**

Most correlation and calibration research for developing soil tests and interpretations were done with pre-plant samples. As the time of sampling is done further before planting time, as in the previous fall, possible changes by climatic conditions need to be considered. Nitrate is assumed to move down the soil profile with rain or irrigation. Some research suggests that phosphorus does not change significantly over the winter in the Lower Fraser Valley, whereas potassium has been found to increase in some cases.

**3. What if different sample depths are used?**

Fertilizer recommendations were developed using the recommended depths in **Table 1**. Immobile nutrients (P and K) are considered separately from mobile nutrients ($NO_3$).

*Immobile nutrients*

For immobile nutrients, if a sample deeper than 15 cm is taken, the nutrient concentrations will likely be lower and the fertilizer recommendations greater. This is because of lower concentrations at subsurface depths. For example, in the Fraser Valley Soil Nutrient Study of 2005, phosphorus was on average 45% lower in the 15-30 cm depth than the 0-15 cm depth, and potassium was 32% lower.

Kowalenko, C.G., Schmidt, O. and Hughes-Games, G.A. 2007. Fraser Valley soil nutrient study 2005. A survey of the nitrogen, phosphorus and potassium contents of the Lower Fraser Valley agricultural soils in relation to environmental and agronomic concerns. http://www.agf.gov.bc.ca/resmgmt/EnviroFarmPlanning/FV_SoilNutrientStudy/_FVSNS-CombinedReport_Feb28_2007_for_Release.pdf

If a sample shallower than 15 cm is taken, it will not make much difference to P and K concentrations if the surface soil has been cultivated to at least 15 cm; if there was minimum tillage (e.g. perennial grass), shallower sampling would result in higher soil nutrient concentrations and lower fertilizer recommendations.

*Mobile nutrients*

For mobile nutrients, a deeper sampling depth becomes more important if there has been leaching after harvest. If rain washes soil nitrate below 30 cm before a post-harvest nitrate sample is taken, a sample from 0-30 cm would indicate no residual nitrogen – a false interpretation of the actual situation.

**4. How do sampling locations in fertilizer-banded fields affect results?**

Increasing the proportion of sampling locations from or near the fertilizer bands will increase the soil test values of nutrients (particularly immobile nutrients like phosphorus and potassium) for the field. This would mean that the fertilizer recommendation will be lower. Since the plants will probably feed mostly from the banded areas, i.e. use the fertilizer more efficiently, the fertilizer recommendation would be more appropriate. However, if you do not take enough cores to make your composite sample, soil samples that include (rather than exclude) the fertilizer band have the greatest deviation or variation from the 'true' values.

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