Phosphorus Considerations for Nutrient Management

Nutrient Management Factsheet – No. 6 in Series

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Soils that have an elevated phosphorus (P) concentration can pose a risk to surface water sources. This factsheet gives agricultural management guidelines to minimize the risk of phosphorus pollution of sensitive receiving environments.

Movement of soil P into freshwater lakes or streams can speed up eutrophication, associated with algal blooms followed by depletions in the water's oxygen supply caused by the algae's death and decomposition. Eutrophication has led to fish kills and restrictions of water use for recreation, drinking and industry.

In general terms, soil P can be transported into waters in sediment-bound or dissolved forms. Sediment-bound P includes eroded soil and organic matter particles, which may not cause eutrophication immediately but is a long-term source of P in aquatic systems. Most dissolved P in runoff is immediately available to cause eutrophication.

Identifying Sensitive Receiving Environments

High phosphorus soils are a concern in the following circumstances:

- Where streams and drainage systems empty into lakes
- Where there is opportunity for soil P transport from the fields to surface waters
- Where fields have subsurface drainage systems that empty ultimately into a lake system

Areas likely to have P-sensitive surface waters include but are not limited to the Okanagan Basin, Christina Lake Basin, Thompson River system from Savana and areas in Schedule 5 of the *Municipal Sewage Regulation.*

In areas of BC where fresh water and subsurface drainage systems drain into major rivers that enter salt water, high phosphorus soils are not a major concern at this time.

In phosphorus-sensitive areas of BC, fields that are located well away from freshwater and where there is no risk of P transport into freshwaters, high phosphorus soils are not considered a major concern at this time.

Management Practices to Minimize Phosphorus Loss by Erosion and Runoff

In sensitive receiving environments, the following management practices are recommended:

- Do not apply manure or fertilizer when there is risk of surface runoff from rain or snowmelt into the stream
- Establish well-vegetated buffer strips between the stream and field to catch eroded material
- Do not apply manure or fertilizer in the buffer strips
- Avoid over-applying P in manure and fertilizer to keep soil concentrations in the optimum range (**Table 1**), since phosphorus concentrations in runoff (surface and subsurface) increase with soil P concentration
- Improve irrigation and drainage management to minimize erosion and runoff
- Plant cover crops where practical to reduce erosion in fields with high soil P
- Direct surface runoff to retention/settling ponds

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Phosphorus Loss through the Subsurface

Phosphorus can also move downward through the soil into drainage systems, and enter surface water through this route.

The main route of phosphorus movement downward through the soil is by preferential flow which is the rapid movement of soil water (and liquid manure) through cracks, fissures and biological macropores (worm borings) in the soil directly to drain tiles or groundwater.

Although P-binding capacities of soils are generally high, soils have limits to their P-binding capacities and these capacities vary with soil properties. In soils with high or excess phosphorus concentrations that exceed the soil's P binding ability, some phosphorus can leach and enter surface waters by subsurface flow.

Management Practices to Minimize Phosphorus Loss from Drainage Systems

The following practices will help minimize the risk of phosphorus loss through subsurface-drainage systems:

- Tile-drained fields in sensitive areas should be tilled before manure or fertilizer application in the spring to break up cracks and macropores.
- On fields in perennial forage where pre-application tillage can only be done with slurry application tillage implements like "Aerway", you can also limit phosphorus loss in drain tiles by applying liquid manure in several small applications throughout the growing season.

Management Practices for Reducing Phosphorus Concentrations

Soil testing is an important part of managing fields and crops to avoid phosphorus buildup. **Table 1** provides general agronomic soil test ratings to assist planners and farmers in developing a strategy for P management.

Soil test P methods were evaluated for some BC soils in recent years for environmental purposes. Results suggested that in the Lower Fraser Valley, agronomic soil P ratings (similar to the ratings in **Table 1**) could be used for assessing risk of P loss from soils due to water[1]. If receiving waters are not sensitive to P loading, however, the risk of P pollution is minimized. In general, P is bound more than two times as tightly in Fraser Valley soils in comparison to Okanagan soils[2]. This alone suggests that environmental soil P limits for the Okanagan should be lower than those in Table 1; however, naturally low precipitation in the Okanagan reduces the overall risk of soil P *transport* into surface waters[2]. Although a single set of soil P limits may not be appropriate for all soils and requires careful interpretation for environmental purposes, agronomic soil P ratings like those in Table 1 should be considered a first step in a comprehensive management plan for phosphorus.

Table 1. Target indices for soil test phosphorus (P) for mineral soils in BC (0-15 cm sample depth).

Soil test P*	Management Strategy
< 40 ppm	**Low to Medium**– crops may respond beneficially to additional P
41 – 75 ppm	**Medium to Optimum** – aim to maintain levels in this range
76 – 100 ppm	**High** – aim to reduce soil P levels; additional P (except as starter P) is likely to have minimal benefit to crops
> 100 ppm	**Excess** – aim to reduce soil P levels; additional P (except as starter P) is not likely to benefit crops for at least 2 years

*Values are provided for the Kelowna extraction method. To compare with results of other methods, see Factsheet 3 of the Nutrient Management Factsheet Series.

Fields with low to medium levels of soil P: Manure can be applied at rates to meet the entire crop P requirement as long as it does not exceed crop nitrogen requirements.

Fields with optimum levels of soil P: These fields have enough P to meet the requirements of most crops this cropping year.

If soil P approaches high levels, decrease the average annual application rate of manure to account for crop-available P from manure applications in the current and previous years. This might be done by applying manure one year and none the next – an alternative to reducing application rates by half each year. Assume 50% of the manure P is crop-available in the year of application to ensure sufficient P is applied; most of the remaining P will build up soil P and become crop-available in the following years.

Fields with high or excess levels of soil P: Even with high or excess soil P levels, some annual crops like corn may respond favourably to about 25 kg/ha (22 lbs/ac) phosphate fertilizer (P_2O_5) as a starter fertilizer. At high soil P levels, crops have enough 'money (P) in the bank (soil)' to do well without other additions of phosphorus.

It is recommended that fields in sensitive areas with high or excess soil P levels receive no manure or fertilizer phosphorus until soil levels decline. Manure should be applied instead to fields that are low in phosphorus or less vulnerable to soil P transport.

If manure must be applied to high phosphorus fields, ensure that the fields that receive the most manure are located at the greatest distance from surface water or ditches. In these fields, more than 50% of the total manure P is crop available in the year of application and this percentage increases up to as much as 100% at very high soil P levels.

Long Term Strategies

If all the fields on a farm have high phosphorus levels and are at risk for P transport into sensitive waters, management becomes more difficult. Because all excess phosphorus remains in the soil for future crops to use, it will become increasingly important to have strategies that allow farmers to minimize manure applications to high phosphorus soils.

As manure application rates are decreased (to reduce soil P loading), it will be more important to ensure crop nitrogen (N) requirements are still met.

- Increase attention to conserving more manure nitrogen by using equipment and practices that decrease ammonia emissions from spreading[3].
- Using mineral fertilizer to satisfy part of the crop N requirements has benefits: a more predictable supply of nitrogen and often better uniformity of application compared to manure.
- Alternatively, legumes can effectively replace significant amounts of N fertilizer by 'fixing' nitrogen from the air. Incorporate legumes into the crop rotation if possible.

Work with nutritionists to fine-tune animal diets or feeding strategies to reduce P imports onto the farm in feed or to balance rations to allow animals to use more P from feed so that less P is excreted in manure.

Seek arrangements over the next few years to export manure phosphorus off the farm. Developments in technologies may emerge to make this more feasible. These developments could include composting to allow for easier transport, better solid-liquid manure separation, struvite extraction of phosphorus from manure, or gasification of manures producing ash and energy. Globally, there is a growing demand for phosphorus fertilizer, so excess manure P will be increasingly valuable if it can be transported to those markets.

References

1. 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.

2. Kowalenko, C.G., Schmidt, O., Kenney, E., Neilsen, D. and Poon, D. 2009. Okanagan agricultural soil study 2007. A survey of the chemical and physical properties of agricultural soils of the Okanagan and Similkameen Valleys in relation to agronomic and environmental concerns.

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3. For an interactive demonstration of how environmental conditions and equipment can reduce nitrogen (ammonia) emissions from liquid manure spreading, see the Ammonia Loss from Applied Slurry Manure tool online at Farmwest.com

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