ACTIVITY 1
4R NUTRIENT STEWARDSHIP ASSESSMENT

Led by the University of Guelph and support from the HMGA

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Researchers at the University of Guelph were able to analyze PRS probes and soil samples collected from the farmer fields and the University of Guelph Muck Crops Research Station for phosphorus (P). The muck soils in Holland Marsh were found to have high soil test phosphorus (P) concentrations which suggests a risk for P to be released into adjacent surface waters.

- The median Olsen P concentration for the collected spring soil samples was 119 ppm (Interquartile range 86-152 ppm).
- The median Olsen P concentration for the carrot fields was 100 ppm, whereas the median for the onion fields was 119 ppm.
- Out of the 15 fields sampled, only one had an Olsen P concentration of less than 60 ppm, which indicates a P application as per the 2010-2011 OMAFRA recommendations (Publication 363).
- The median Bray P concentration for the analyzed spring soil samples was 77 ppm (Interquartile range 66-116 ppm).
- Phosphorus supply rates estimated from the PRS probes varied substantially across fields with a median of 3.9 mg/m2/35 days and an interquartile range of 1-16 mg/m2/35 days.
- The mean soluble reactive P concentration in the soil pore water collected from the lysimeter that was installed in the carrot field located in the University of Guelph Muck Crops Research station was 0.24 ppm whereas the onion field showed higher SRP concentration (0.58 ppm).

This was consistent with the higher soil test P concentrations (and higher P application rates) observed in the onion field. Only half of the farmers (n=10) who agreed to install the probes on their farms actually did so and allowed the researchers to sample soils for further P analysis.

A literature review on the implementation of 4R management strategies to mitigate phosphorus (P) losses from cultivated muck soils has been completed.

The researchers formulated a number of recommendations addressing the need to develop a solid foundation for a phosphorus reduction strategy. Seven recommendations lifted from the report are presented below.

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RECOMMENDATIONS

1. **Need to confirm the appropriate soil phosphorus test for the muck soils of the Holland Marsh.**

Findings from this review suggest that soil P tests developed for mineral soils (including the Olsen P test) may not be the most suitable test for organic soils, and that a variety of extractants, including Mehlich-3 and Bray-1, should be correlated with plant uptake of P on organic soils from the Holland Marsh. This would involve multi-year fields trials with major crops grown in the region as outline below (Priority Point 4).

2. **Determining the most appropriate soil test phosphorus sampling protocol for the organic soils of the Holland Marsh**

In addition to verifying the correct soil extractant for organic soils, consideration should be given to weighing rather than scooping samples for analysis. This step could be implemented immediately in accredited soil testing labs in order to provide more accurate soil test results.Further, establishing standardized protocols for sample collection and processing of organic soils including drying temperature and time, is essential. This will help standardize protocols across accredited soil testing laboratories and ensure the laboratories are providing more standardized results. This is a critical step as it is difficult to recommend a rate if the soil test P concentration of a sample is not reliable.

3. **The implementation of 4R should begin avoiding the over-application of P fertilizers.**

Preliminary results from our recent research and other studies conducted in Holland Marsh indicate that most commercial fields exhibit sufficient or excess soil P. Existing literature, including reports from the Holland Marsh region, indicates that the overapplication of P fertilizer does not enhance crop yields. Therefore, the application of P to fields where the soil test P concentrations are higher than that where fertility applications are recommended, should be discouraged, and efforts should be directed towards drawing down soil test P concentrations over time through crop removal. In general, as long as more P is added than is removed, soil test P concentrations (and therefore risk of environmental P loss) will increase over time.

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RECOMMENDATIONS

4. **Development of crop-specific fertilizer recommendations based on baseline soil P** The current Ontario P fertilizer recommendations for vegetable crops cultivated in organic soils must be reviewed and updated in alignment with the new soil test P and protocol. Limited studies have been conducted that correlate soil test P concentrations with plant P uptake in organic soils of the Holland Marsh. It is recommended that multi-year fields trials with major crops grown in the region. One limitation may be finding low soil test P soils to conduct the trials on. Having an accurate recommended rate is a critical step in reducing the risk of environmental P loss and is necessary to promote grower confidence in being able to reduce their P application rates.

5. **Adaption of other Rs- source, placement and timing**
The incorporation of other Rs in the 4R nutrient stewardship should be implemented with care, given the complexity of vegetable cropping systems. Critical aspects of transitioning conventional vegetable cropping systems into more sustainable ones through 4R management need to be thoroughly explored through scientific inquiry.
Further research on using alternative P sources that are less water soluble, such as struvite, should be conducted. Other sources, like manure and compost may have a reduced potential to become alternative sources in these organic soils considering their contribution to soil test P accumulation in agricultural soils and potential food safety concerns.

The effectiveness of placing P fertilizers with the seed to reduce P losses is unclear in these organic soils. In the trials conducted in the 1970s and 1980s in Holland Marsh, the subsurface placement of fertilizers did not appear to have a positive effect on vegetable yields due to high background soil P. The potential benefits of subsurface placement may become evident upon achieving a reduction in soil test P concentrations through lower P application rates.

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RECOMMENDATIONS

5. Continued.

Holland Marsh growers do not apply fertilizers in the fall or winter, periods prone to higher flow-related P losses. Considering practices such as split application may help reduce incidental P losses during major spring and summer rain events, although the only feasible application appears to be foliar once the seed bed is established.

6. **6rower engagement and awareness**

Grower support and engagement are crucial for the success of any nutrient reduction strategy. For instance, in southern Florida, a reduction of over 50% in total P loss from cultivated organic soils was accomplished with 100% grower participation (Daroub et al., 2011). The University of Guelph and the OMAFRA have been engaged in grower-focused knowledge translation and transfer activities through grower focused symposiums and summer field days. It is essential to continue grower-focused knowledge translation and transfer activities to educate farmers about the benefits of sustainable nutrient management considering both their net returns and the environment.

7. **The role of Ag retailers**

Survey results from growers have indicated that the majority of producers in the Holland Marsh rely exclusively on independent agricultural retailers for soil testing, nutrient recommendations, and fertilizer application. In this context, agricultural retailers and crop consultants are an essential stakeholder and any P reduction strategies should include their participation in order to achieve more immediate and tangible benefits. It is also important that Ag-retailers work with OMAFRA to ensure that they are following the most up to date P recommendations that are available for Ontario horticulture systems.

The HMGA is pursuing these recommendations in an effort to further position the sustainability of the Holland Marsh vegetable production.

For more information contact Jody Mott at hmgaexec@gmail.com.