Ontario Soil Management Committee
GUIDELINES Regarding Data Requirements for New or Revised Nutrient Recommendations

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Introduction:

This document is to provide guidance for any individual or group planning trials with the intent of presenting proposed changes to provincial crop nutrient recommendations to the Ontario Soil Management Committee (OSMC). Fertility recommendations can be for any nutrient, from any source (commercial fertilizer or organic sources) for the production of any agricultural crop grown in soil (e.g., excluding greenhouse grown crops).

The responsibility of the OSMC is to approve recommendations based on the best agronomic, economic, and environmental data available. The committee reserves the right to make decisions regarding the adequacy of any data set. Following the guidelines in this document will help to ensure that any field work accurately reflects the agronomic and environmental responses to nutrients in Ontario.

Soil management recommendations are not specifically mentioned in this document, but similar data would be required to change provincial published recommendations. Guidelines for other recommendations may be formed as part of the process of data review by the OSMC.

General Principles:

The design of any project will depend on the specific questions being asked, and criteria, such as number of replications and range of treatments, need to be sufficient to detect the smallest difference of interest. This means that what is "sufficient" for a particular project will vary with the variability of the parameters being measured, and the size of the difference that needs to be detected. Involving a research scientist in the project planning is strongly recommended, to ensure that the trial results will be scientifically defensible. Industry representatives should also be involved in the research development process, to ensure that the data collected reflects what is important to the industry.

In addition to the primary focus of a research project, additional parameters need to be measured for the trial results to be useful to OSMC. For agronomic trials, some indication of the environmental impacts of the treatments must be included. Similarly, for trials with an environmental focus, the agronomic implications of the trial results need to be presented. In any case, descriptive information for each site (e.g., previous crop, soil texture, soil pH, previous nutrient applications, etc.) needs to be provided, to allow interpretation of the trial results in context.

Standard commercial production practices should be followed in planting, pest control, all other nutrients but the one(s) of interest, and harvesting the plots, to ensure the results are reflective of what would happen in grower's fields.

Individual Site Requirements:

Replication: Number of replications necessary to identify a difference between treatments will depend on the inherent variability of the trial site (more variability means more replications), and the size of the difference being measured (smaller differences mean more replications).

Range of Treatments: Essentially all nutrient requirement data will be subjected to some form of regression analysis, so there need to be enough treatments to allow the calculation of an appropriate "best fit" curve. A minimum of four treatments is required for most recommendations, but including more treatments in the trial will increase the precision of the curve fitting. The range of treatments should bracket the "expected" optimum value, with the highest rate aiming to be above the rate that produces the maximum yield. There should be more treatment increments below the expected optimum than above, and the lowest rate should be as close to zero as possible (e.g. many N trials will include starter fertilizer that is applied across all treatments).

To change an existing recommendation, the original recommendation should be included within the range of treatments tested.

Zero treatment (check): A check treatment is essential for comparison; it is impossible to determine whether a lack of difference is due to a non-responsive site without including a check. There are significant benefits to including a zero in the trial, including the ability to calculate the Applied Nutrient Use Efficiency, and a reduced risk that the trial will not predict a precise optimum nutrient rate. If there is no response to a nutrient across the range of treatments, and the lowest rate is not zero, the most precise conclusion that can be reached is that the optimum rate is somewhere between the lowest treatment rate and zero.

Minimum Site-Years:

The number and distribution of the sites must be appropriate for the extent and the distribution of the crop in the province. The length of the trial will depend on the amount of year-to-year variation, so more than one year will be required to determine how much temporal variation exists. There is no absolute standard for minimum site-years required to determine the adequacy of a particular data set, since it will depend on the distribution of the particular crop, and on the amount of variability between sites and between years.

For crops with limited research capacity within Ontario, data from outside jurisdictions may be considered, provided it comes from an area with similar climate, using similar agronomic practices, and meeting other criteria required. Preference is given to Ontario-based data.

Site Characteristics Required:

General information is required for every site and site-year, including a precise location identifier (e.g., UTM co-ordinates), description of soil type and drainage class, tile drainage, and previous management including crop rotation and previous amendment (e.g., manure) applications that may influence the response to added nutrients. General soil tests for the site should be available, including soil pH.

Soil tests appropriate to the parameter being measured should be collected prior to nutrient application. At a minimum, samples should be collected from each replication. A better practice is to collect samples from each treatment plot. Nitrogen trials should have samples analyzed for nitrate-N and organic carbon (identify method/timing of soil sampling). Trials for other mineral nutrients should include soil sample analysis (using OSMC approved soil tests) for the available fractions of the nutrient in question. Nutrient assessments where soil tests are unavailable should include another measure of nutrient availability, such as plant tissue tests.

Information about the cultural practices used at each site (cultivars, tillage, planting, and harvest dates, weed control, etc.) must be available. Seasonal weather data is available publicly, but temperature and rainfall measurements made on-site are preferable.

Interpretation of Yield Measurements:

Yield measurements should be based on marketable yield, which may be different from total yield. Quality parameters may also need to be incorporated into the economic assessment, where appropriate for the crop. The most appropriate assessment will be the response of the economic value of the crop (marketable yield times price) to the nutrient application. Quality parameters need to be included in the determination of the price of the crop, where appropriate (e.g., protein in wheat; evenness of ripening in whole-pack tomatoes).

Where appropriate, the yield response will be fit to a mathematical model, to allow interpolation between the data points and precise determination of the Maximum Economic Rate of Nutrient (MERN). The model chosen should reflect the physical nature of the response, as well as a mathematical best fit. Curve fitting should be done using all available data (as opposed to averages of treatments across replications). Where outliers are excluded, the reasons for omitting the outliers from the analysis must be provided.

A number of different models may be statistically appropriate for various trials. These include:

i. quadratic – most commonly used, reflects principle of "diminishing returns"
ii. quadratic plateau – fit to data with no response in upper range of treatments
iii. linear or linear plateau
iv. Mitscherlich – generally close to quadratic plateau, but does not allow calculation of maximum attainable yield
v. spherical plateau

Mandatory Measures of Environmental Risk:

OSMC makes recommendations based on the risk of environmental impact as well as agronomic response, and must have relevant data to make appropriate decisions. Any trial where there is reasonable expectation that negative environmental impact could occur (e.g., potential increase in nitrate leaching from higher nitrogen rates) must include measures of the environmental impact. Where a large body of knowledge already exists regarding the environmental impact of the range of application rates being studied, this requirement may be met by reference to relevant existing information. In other cases, the body of knowledge may

not exist, or the responses are expected to be site specific, so measurements of the environmental impact will be required.

Measures of environmental risk should include, at a minimum:

i. Change in apparent nutrient use efficiency between rates of nutrient application
Apparent Nutrient Use Efficiency = (nutrient uptake in fertilized plot – nutrient uptake in unfertilized plot in kg/ha)/(quantity of nutrient applied in kg/ha)

ii. Partial nutrient balance
Partial nutrient balance = atmospheric deposition + historical nutrient balance – crop removal

These can be determined by multiplying the total biomass production of crop residues and the harvested portion of the crop by their respective nutrient content. Total uptake is the sum of the nutrient content of the portion of the crop removed from the field and residue nutrient content. If yield measurements are the only data available, it may be acceptable to estimate the nutrient content of the residue from book values for harvest index and residue nutrient concentration, but this limitation to the data must be reported.

Actual measurement of residual mineral soil nitrogen can take the form of analysis of a sample from the top 30 cm of soil for nitrate content following crop harvest (measured on a plot-by-plot basis), or by the nitrate concentration in the soil solution as collected in suction lysimeters or pan lysimeters. Gaseous N losses do not need to be determined on an individual plot basis, but researchers should point to relevant work being done specifically on NO_x emissions.

Environmental measures do not need to be collected on all plots but must be sufficient to characterize the relationship between nutrient rate, crop response and environmental risk. Failure to include this information with the trial results significantly increases the risk that the committee will be unable to support the proposal.

Discussion of Impact:

Any proposal for a new or revised recommendation should include discussion of the potential impacts, to allow a rational discussion of the risks and benefits associated with the proposed change to recommendations. This includes an assessment of changes in total nutrient use, crop yield, and environmental impact. For most fertilizer recommendations, the scale of this assessment will be within the field, but some changes will have broader implications that should be considered (e.g., changes to nutrient credits from manure). Any significant regional trends should be noted if the recommendation varies between areas.

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