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organic SCIENCE CLUSTER 3

Improving Organic Vegetable Farm Sustainability through Enhanced Nutrient Management Planning

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Submitted by Sean Smukler

Nutrient management is one of the primary reasons that organic farms, particularly those producing vegetables, have lower yields than non-organic farms. Undersupply of nutrients can result in reduced crop yields and income. At the same time, applying nitrogen (N) or phosphorus (P) above what the crop can use can result in nutrient leaching and runoff into water resources, contribute to poor air quality and emit climate-changing greenhouse gases. Managing this trade-off is difficult given that outcomes can vary widely with the types of amendments organic farmers have access to, their climate, and soil conditions. The objectives of this project were to trial various organic nutrient management options to give farmers a better understanding of their potential economic and environmental trade-offs and to develop tools to enhance nutrient management in the future.

Masters student Amy Norgaard harvesting vegetables at a daughter farm site (Photo SAL Lab).

Methods:

In 2018 the Sustainable Agricultural Landscapes (SAL) Lab at the University of British Columbia (UBC) launched a set of coordinated field trials. Post-doctoral fellow Dr. Kira Borden led the establishment of a controlled experiment on two working farms (“mother farms”) with distinct management histories and soils. The UBC Farm in the Fraser Valley is on coarse-textured soils and Greenfire Farm on Vancouver Island is on fine-textured soils. At each site, four treatments were established in replicated plots (Table 1). Potatoes were grown in the first year and cabbage and cauliflower in the second year.

To evaluate how economic and environmental trade-offs of different nutrient management strategies vary by soil type, climate conditions and cost of nutrients, we also established field trials on 20 mixed vegetable farms (“daughter farms”) across three regions of southwest BC. These trials were led by master’s student Amy Norgaard. At the daughter farms, we compared the same treatments as at the mother farms (Table 1) but without a control, as that could have led to lower yields.

Table 1. Four nutrient management strategy treatments repeated in 2018 and 2019

Treatment	Description
High Compost	compost applied at a rate targeting crop N needs (removal)
Low Compost+N	compost applied at a rate targeting crop P removal + feather meal N to match crop N removal
Typical	compost and/or fertilizer applied using the farm's typical approach
Control	no compost applied

Throughout the project, compost, crop, cover crop and soil samples were analyzed using standard laboratory techniques. These samples were also run on the SAL lab's Fourier Transform infrared spectrometer to develop a spectral library to reduce the cost and time of analyzing these materials in the future. Data from field trials was used to parameterize and validate an ecosystem process model to better predict the availability of nitrogen. Nutrient management information was also incorporated into the online tool LiteFarm to help farmers evaluate the impacts of their own nutrient management strategies on crop yields, soil organic matter and economics.

Results:

At the experimental farm sites there were larger yield gains (yield compared to control) for potatoes under High Compost compared to Low Compost+N, but no differences between nutrient management strategies for the brassicas. Potato yield gains were more pronounced at Greenfire Farm than at UBC Farm. We also consistently observed more efficient use of N with Low Compost+N, which resulted in about 20-100 percent of applied N being recovered (taken up) by the crops, while less than 20 percent of N was recovered in the High Compost plots. This trend was mirrored for P recovery but with some crop-specific exceptions at UBC Farm. Despite the high costs of organic fertilizer, the Low Compost+N was less expensive for meeting yield targets than High Compost, particularly on Vancouver Island where compost access is limited.

In our regional field trials, we found no consistent differences in yields when all three regions were considered. The exception was in the second year, in the Fraser Valley (a region characterized by inexpensive, high-nutrient content composts and soils high in P), we observed greater yields in High Compost than Typical. We also found no consistent differences in input costs except for the Fraser Valley, where Typical was the lowest.

Overall, across all regions we observed 21 percent higher levels of P left behind in the soil with *High Compost* than *Low Compost+N*. We also found that *High Compost* resulted in elevated soil nitrate levels after the crop was harvested at farms using high-N compost (sampled 0-30 cm deep in the soil). These extra nutrients left behind in the soil could be cause for environmental concern if there is no cover crop planted to recover them.

Throughout the project, we collected more than 300 compost, cover crop and soil samples. Using these samples, we have built a spectral library which enables us to predict carbon and nitrogen contents of these materials with accuracies above R2 values 0.95 at 10% of the cost and time required with other laboratory methods. Our efforts to parameterize an ecosystem process model to better predict nitrogen availability however was not successful. The fit of the model was poor. Finally, prototypes for calculating nutrient management calculations have been developed for implementation in LiteFarm.

Plot establishment at Greenfire farm on Vancouver Island, British Columbia (Photo by Sean Smukler)

Conclusions and Recommendations:

Results from our mother farm trials clearly showed more efficient use of nutrients and lower costs with Low Compost+N. Using this approach can minimize the trade-offs between economic and environmental objectives. Results from the daughter farms were similar, but our findings were less pronounced given the variability across regions and differences in farm management. The daughter farm analysis highlighted key regional differences in the access to composts and manure and associated costs of using these materials. The regional trials also confirmed that ineffective nutrient management results in increased environmental risk (due to potential nutrient loss), but also that many organic farmers in BC are already managing these trade-offs effectively.

Future Research:

Given that nutrient management strategies are expected to slowly change soil properties such as P and organic matter, future research should focus on evaluating long-term impacts. In particular, changes in soil organic matter should be assessed for their impact on nitrogen availability and the potential to offset greenhouse gas emissions through carbon sequestration. Improving P use efficiency in organic production remains a key challenge. Ultimately, nutrient management options should be evaluated in the context of the long-term economic outcomes of the system.

Postdoctoral fellow Dr. Kira Borden harvesting from experimental plots at the UBC Farm, British Columbia (Photo by Sean Smukler)

For more information visit the OSC3 Activity 14 webpage and/or DAL.CA/OACC/OSCIII & https://organicfederation.ca/organic-science-clusters/

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