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SUSTAINABLE ORGANIC VEGETABLE SYSTEMS: EVALUATING GREEN MANURE AND BIOWASTE COMPOSTS (2006-2009)

Interim Research Report E2010-51

BACKGROUND

Demand for local and organic vegetables continues to increase. Organic production systems rely heavily on soil fertility for nutrient supply. The soil fertility in these systems must be maintained via a suite of management practices such as organic amendments (i.e. manure, compost), green manure, and rotating high and low nutrient demanding crops. At the same time, compost production in Canada increased by 104% in six years, from 980,000 tonnes in 2000 to more than 2.0 million tonnes in 2006 (Statistics Canada, 2006). This provides a unique opportunity to develop a sustainable high-value organic vegetable production system that combines green manures in the rotation with biowaste composts.

The sustainability of a cropping system is linked with productivity, quality, economics and environmental impacts. Limited information is available on productivity, soil nutrient dynamics and environmental impact within organic cropping systems. This project was established to characterise the impacts of biowaste composts in combination with green manure on crop productivity, nutrient availability, soil quality and greenhouse gas emissions in four different 5-year high-value organic vegetable (potatoes, beans, and carrots) rotations.

METHODS

This project was established at the Nova Scotia Agriculture College experimental site (Truro, NS) in 2006. Four crop rotation sequences (C1-C4) include:

1. Oats/Red Clover (O/RC)-Red Clover-Potato (P)-Oats/Red Clover-Carrots (C)
2. Oats/Red Clover-Red Clover-Potato-Beans/Buckwheat (B/Buck)-Carrots
3. Carrots-Peas/Oats/Vetch (PeOV)-Potato-Oats/Red Clover-Beans/Buckwheat
4. Beans/Buckwheat-Peas/Oats/Vetch-Potato-Oats/Red Clover- Carrots

Each rotation plot was divided into four sub-plots: control, mineral fertilizer, municipal food waste compost (MSW; 12 Mg ha^{-1} wet weight; DM=59%) and composted paper mill fibre (LP; 37 Mg ha^{-1} wet weight; DM=33%). Composts are applied in the potato year only (one year in five) to supply soil P requirements. In 2008, soil samples were collected from 0-15 and 15-30 cm depth from the potato phase prior to planting, at tuber initiation, at tuber bulking and after harvest and analyzed for mineral N concentration. Potato tuber yield, size distribution and defects were measured at harvest. Indices of soil quality including microbial biomass, particulate organic C and N, and acid phosphatase activity were determined in soil samples collected at the tuber initiation stage. Greenhouse gas data were collected from 8th May to 4th December 2008. In 2009, of 36 total plots, 9 were planted in carrots, 6 in beans/buckwheat and the rest in green manures. Carrot yield was determined by harvesting 4 m of the centre row of each sub-plot. Potatoes will be recurring in all rotations in 2010.

PRELIMINARY RESULTS 2008-09

In 2008, total potato tuber yields ranged from 32 to 40 Mg ha^{-1}. Crop sequence in these first three years of the study did not have any effect on total tuber yields. Greater total tuber yields were measured in the fertilized treatment compared with composted paper mill fibre and control, while the yield from municipal food waste compost was comparable (Fig. 1). Tuber size distribution was also influenced by amendment application but not crop sequence. A lower percentage of small (38-51 cm) tubers was measured in the fertilized treatment compared with composted paper mill fibre and control treatments (for marketable yield, see bulletin E2009-51).

In 2009, carrot yield was significantly higher under rotations C1 and C2 compared with C4 (25 and 29 vs. 17 tonnes per ha, respectively). Total and marketable bean yield were not affected by rotation. Yields of 1.3 t ha^{-1} in the C2 rotation were higher than C3 (1.1 t ha^{-1}).

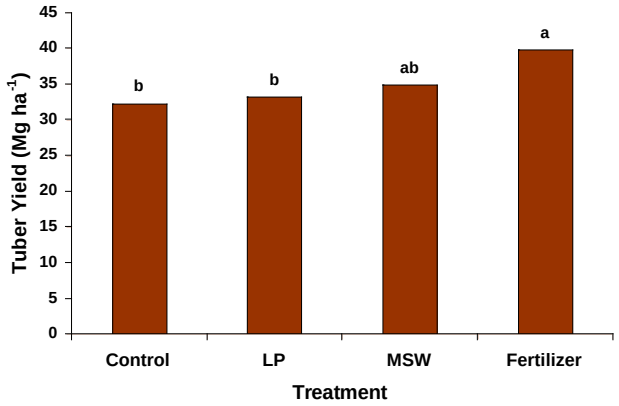

Figure 1. Effect of control, mineral fertilizer, municipal food waste compost (MSW) and composted paper mill fibre (LP) on total potato tuber yield across all rotations.

This may be attributed to more succulent bean growth with higher soil N availability when grown after oats/RCl compared with beans grown after potatoes.

Weed management is one of the major challenges in organic carrot production. The dominant weed species were chickweed, lamb's quarters, corn spurry and grasses. Total weed count (three count dates early in the season) and weed biomass were significantly higher in C1 compared with C2. This shows that buckwheat had a greater weed suppression effect than oat/RCl.

All green manures (red clover or oats/pea/vetch) provided over 100 kg N per hectare to the potato crop in 2008. About 30 kg N ha^{-1} soil mineral N (nitrate and ammonium) was estimated to be lost from the root zone (top 0- 30 cm) over winter (2008-2009) and was not affected by rotation or amendment treatment. In 2008, emissions of the powerful greenhouse gas, nitrous oxide (N_2O) under potatoes ranged from 1.30 to 0.28 kg N_2O-N ha^{-1} for C1 and C3 rotation sequences. In the un-amended control potato sub-plots, emissions were 16% lower on average than under the sub-plots receiving N and P fertilizer (0.82 vs. 0.96 kg N_2O-N ha^{-1}), but two times greater than under the adjacent standing crop of red clover. Greenhouse gas data will be collected intensively again in 2010 and combined with data on soil N dynamics will give us a complete picture of the environmental footprint of these various cropping systems.

REFERENCES

Statistics Canada. 2006. Waste management industry survey: Business and government sectors. Catalogue no. 16F0023X.

THE BOTTOM LINE...

As alternative organic approaches to the conventional intensive rotations and mineral fertilizer application, green manures and off-farm biowaste composts can improve soil nutrient bioavailability, reduce N losses to the environment and sustain soil quality and productivity, while assuring yields comparable to that of conventional production. Sustainable crop production can be achieved through an optimum combination of organic practices including organic amendments and crop rotations.

ACKNOWLEDGEMENTS

Technical support was provided primarily by Jennifer Campbell, Rachel Kennedy and Lloyd Rector.

CREDITS

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FUNDING

Canada Research Chairs Program
The Municipality of Colchester County
Nova Scotia Resource Recovery Fund Board
Nova Scotia Technology Development Program
Province of Nova Scotia
Province of Prince Edward Island

Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada

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