Brassica crop root-rhizosphere strategies for acquiring phosphorus under different rates of compost

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Introduction

It is challenging to synchronize compost application with crop nutrient uptake on organic vegetable farms

- Organic Phosphorus (P_{org}) is not accessible to crops
- Crop roots have strategies to convert P_{org} to plant available P (PO_4^{3-}) in the rhizosphere
- An important enzyme involved in this process is Acid Phosphatase (APase) (Nannipieri, P et al., 2011).
- No consensus regarding how APase activity responds to organic amendments, and the factors affecting this relationship are still poorly understood (Luo *et al.,* 2019)

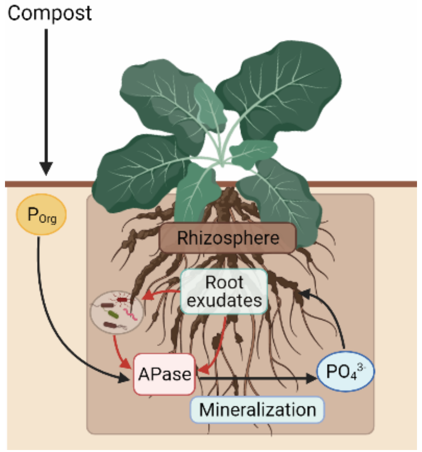


Fig. 1: Diagram depicting the fate of P_{org} added as compost. APase exuded by roots and microorganisms in the rhizosphere mineralize P_{org} and release PO_4^{3-} for crop uptake

Research Questions

1. Does compost application rate impact APase activity in the rhizosphere of *Brassica* crops?
2. Are there differences in APase activity among *Brassica* varieties?
3. Is APase activity related to bulk soil chemistry and crop function?

Results

- There was a significant difference in APase activity among varieties (data not shown) and between the control and low compost treatment (fig. 2)
- APase activity in the rhizosphere was positively correlated with crop P content (fig. 3) and crop yield (fig. 4) for superstar cabbage, but was not correlated with soil Available P (data not shown)

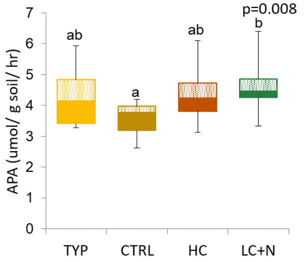


Fig. 2: Mean APase activity in the rhizosphere with three compost treatments and a control. Error bars represent standard error (p=0.008, n=12)

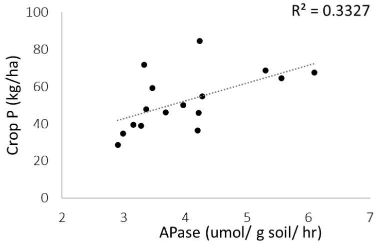


Fig. 3: Relationship between Crop P and APase in the rhizosphere of Superstar (cabbage). (R^2= 0.33, p= 0.018)

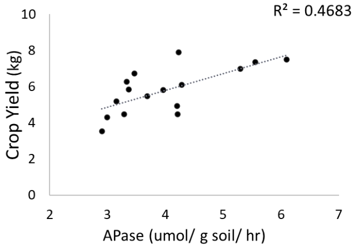


Fig. 4: Relationship between superstar (cabbage) yield (mass per plant (kg)) and APase. (R^2= 0.47, p= 0.003)

Methods

UBC Farm Research site:

- Certified organic farm, sandy soils (Bose Humo–Ferric Podzols)

Experimental design:

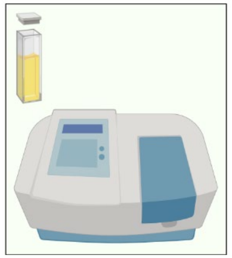
- Three varieties of *Brassica oleracea* (Cabbage: Superstar, Cauliflower: Orbit and 26-701) with three compost treatments (high compost (HC), low compost + organic N fertilizer (LC+N) and farm typical (TYP)) plus a control (CTRL), replicated in four blocks

Rhizosphere soil analysis:

1. Roots sampled at harvest using soil core

2. Rhizosphere soil extracted from roots

3. APase activity analyzed spectrophotometrically



Conclusion

- APase may play a variety specific role in improving P_{org} uptake
- Processes controlling APase activity in the rhizosphere are complex
- Understanding crop-soil- microorganism interactions in P_{org} acquisition is important for improving P efficiencies to benefit the farm and the environment

Next Steps

- Determine P use efficiency using crop nutrient content
- Evaluate confounding factors that may be affecting APase activity, such as soil carbon (C) and nitrogen (N), and C:N:P ratios

References: Nannipieri, P., Giagnoni, L., Landi, L., & Renella, G. (2011). *Phosphorus in Action*. *26*, 215–243. https://doi.org/10.1007/978-3-642-15271-9

Luo, G., Sun, B., Li, L., Li, M., Liu, M., Zhu, Y., Guo, S., Ling, N., & Shen, Q. (2019). Understanding how long-term organic amendments increase soil phosphatase activities: Insight into phoD- and phoC-harboring functional microbial populations. *Soil Biology and Biochemistry*, *139*(October), 107632. https://doi.org/10.1016/j.soilbio.2019.107632

Acknowledgments: I would like to acknowledge this research took place on the traditional, ancestral, and unceded territory of the xʷməθkʷəy̓əm Musqueam people. I would also like to thank the Sustainable Agricultural Landscapes lab for their support and mentorship.