Yield response to organic amendments varies by source, crop, climate, and soil organic matter

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Background

- Organic amendments are most often promoted as a tool for building soil quality through improved physical, chemical, and biological properties
- Many studies have documented site-specific yield benefits of long-term manure application, but short-term yield response is relevant to farmers who do not use synthetic fertilizer
- Because nutrients from organic amendments must be mineralized in soil, yield response is likely influenced by the composition of the amendment (e.g., C:N ratio), local climate, and soil properties

Objectives

1. Develop a global estimate of first-year crop yield response to organic soil amendments
2. Determine the effect of crop species, amendment characteristics, soil properties, and climate on the magnitude of this yield response

Methods

- Systematic literature review and meta-analysis
- Search terms: “organic fertilizer,” “manure,” “compost,” or “meal,” and “yield” in the article title since 1980
- 960 results, but only 53 met review criteria, which included:
  - Annual crop(s) with annual yield estimates
  - Zero fertilizer control
  - Integration of fertilizer and amendments excluded
  - Cover crops excluded
- Extracted data included: amendment type and rate, crop, soil texture and organic matter, irrigation, geographic coordinates, and yield
- Yield response ratio calculated as: *amended yield/non-amended control yield*
- Ratios *ln*-transformed and weighted
- 95% bootstrap confidence intervals calculated and used for comparison

Figure 1. Municipal yard waste compost applied to cover crop field.

Results

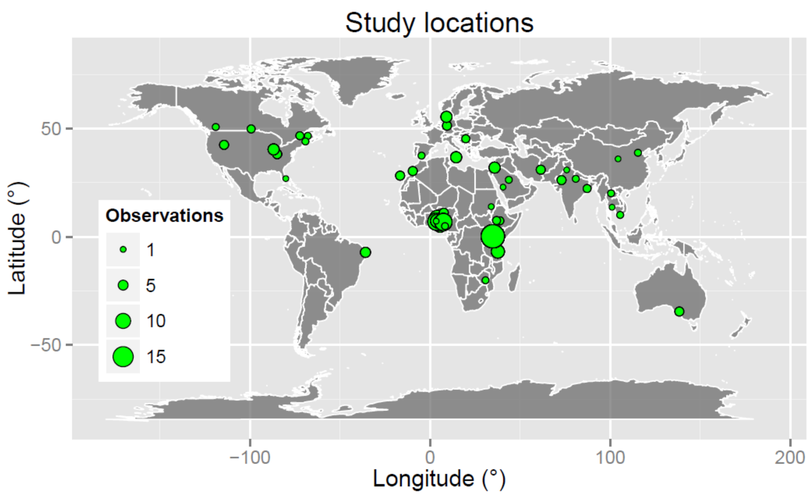

Figure 2. Map of 53 study locations including the number of independent observations included in the meta-analysis.

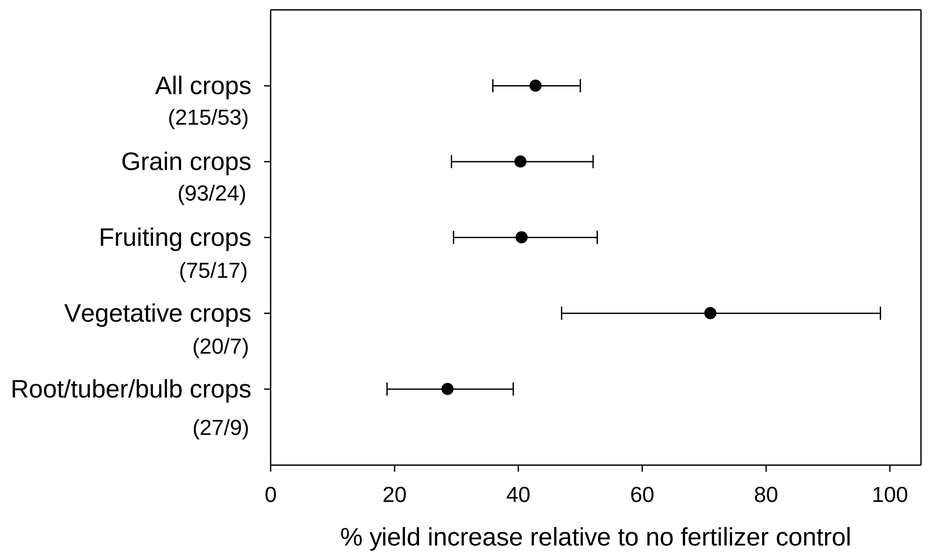

Figure 3. Backtransformed mean yield response to organic amendments relative to a zero fertilizer control among crop types. Numbers below y-axis labels indicate: (# observations/# studies). Error bars represent 95% bootstrap confidence intervals.

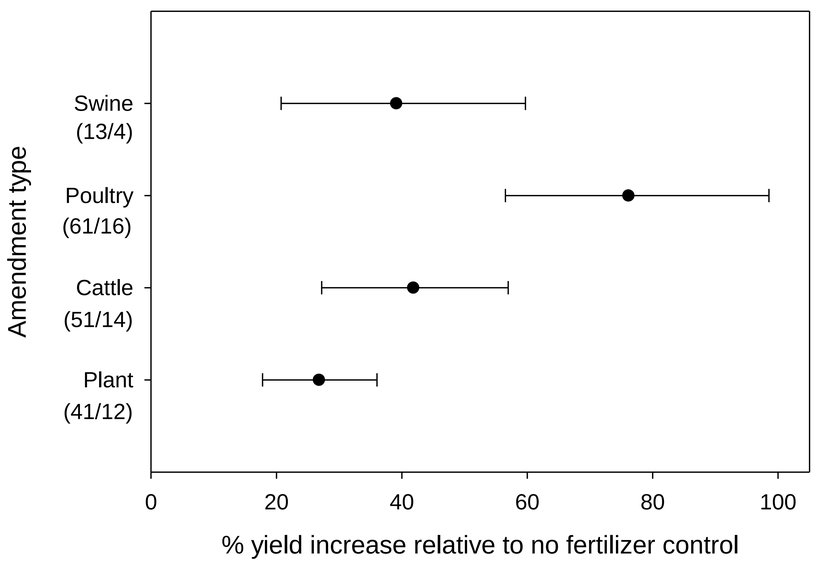

Figure 4. Backtransformed mean yield response to different types of organic amendments relative to a zero fertilizer control. Numbers below y-axis labels indicate: (# observations/# studies). Error bars represent 95% bootstrap confidence intervals.

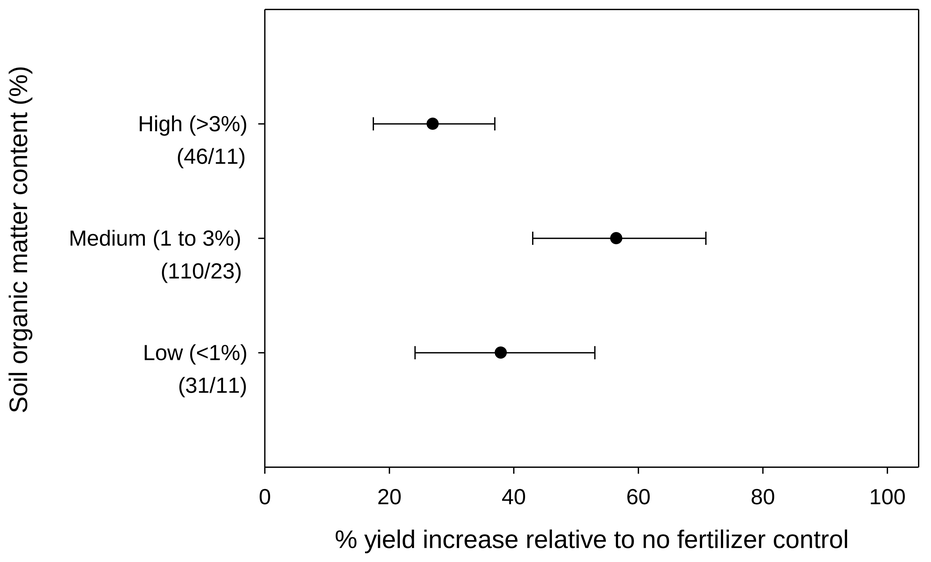

Figure 5. Backtransformed mean yield response to organic amendments relative to a zero fertilizer control among different levels of SOM. Numbers below y-axis labels indicate: (# observations/# studies). Error bars represent 95% bootstrap confidence intervals.

Discussion

- Crop yield increased by 43% in the first season after organic amendment of any type or rate (Fig. 3)
- Yield response was greatest for leafy crops (>70% increase) and lowest for root/tuber/bulb crops (<30% increase) (Fig. 3)
- Poultry manure/compost was the most commonly used amendment and provided a yield increase of nearly 80% (Fig. 4)
- Surprisingly, amendment application rate (on a dry weight or nitrogen basis) was not an effective predictor of yield response
- Yield benefit of organic amendment was muted in soils with high OMC (Fig. 5), possibly due to greater baseline soil fertility
- Organic amendments increased yield by 52% in humid climates, compared to a 32% increase in arid climates, demonstrating the importance of soil moisture in microbial mineralization of amendment nutrients
- Results may help to inform future strategies for maximizing the agronomic value of recycled organic waste (e.g., a diversified vegetable grower with access to composted poultry manure may consider planting lettuce, instead of potatoes, the first season after soil amendment)