

# Temporal change of pH in response to nutrient source and land type in agricultural soils

Teale Weiss-Gibbons, Department of Biology, March 9, 2024

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## Central hypothesis

Biological amendments influence soil pH and is influenced by former land use.

## What is pH

pH is the quantitative measure of hydrogen ions of a liquid solution with values between 0 (most acidic) and 14 (most alkaline).

## Why pH is important

- Availability of inorganic nutrients for plant growth depends on the acidity of the soil. Soils can widely vary in pH and many plants have only a short range of tolerance on this scale.
- Grape vines (pinot noir) are recommended a pH of 5.5 to 6.5 for optimal growth<sup>2</sup>.
- There is a difference in the biology of the soil at different pH, influencing the organic matter cycling and nutrient availability.
- Forest ecosystems typically have acidic conditions and can be due in part to a higher population of acidic enzyme producing fungi.
- Grassland ecosystems typically have more alkaline soils due to the higher levels of alkaline enzyme producing bacteria.
- Synthetic fertilizers are known to acidify soils over time, affecting the nutrient uptake of plants.

How soil pH affects availability of plant nutrients.

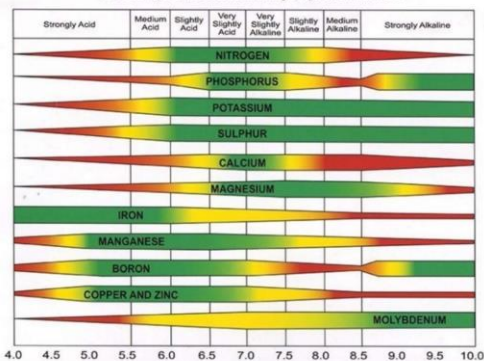


Figure 2. Uses a color scale to indicate the ability of plants to uptake the listed nutrients at varying pH's. Green represents the range of optimal absorption while red represents the lower range of absorption<sup>1</sup>.

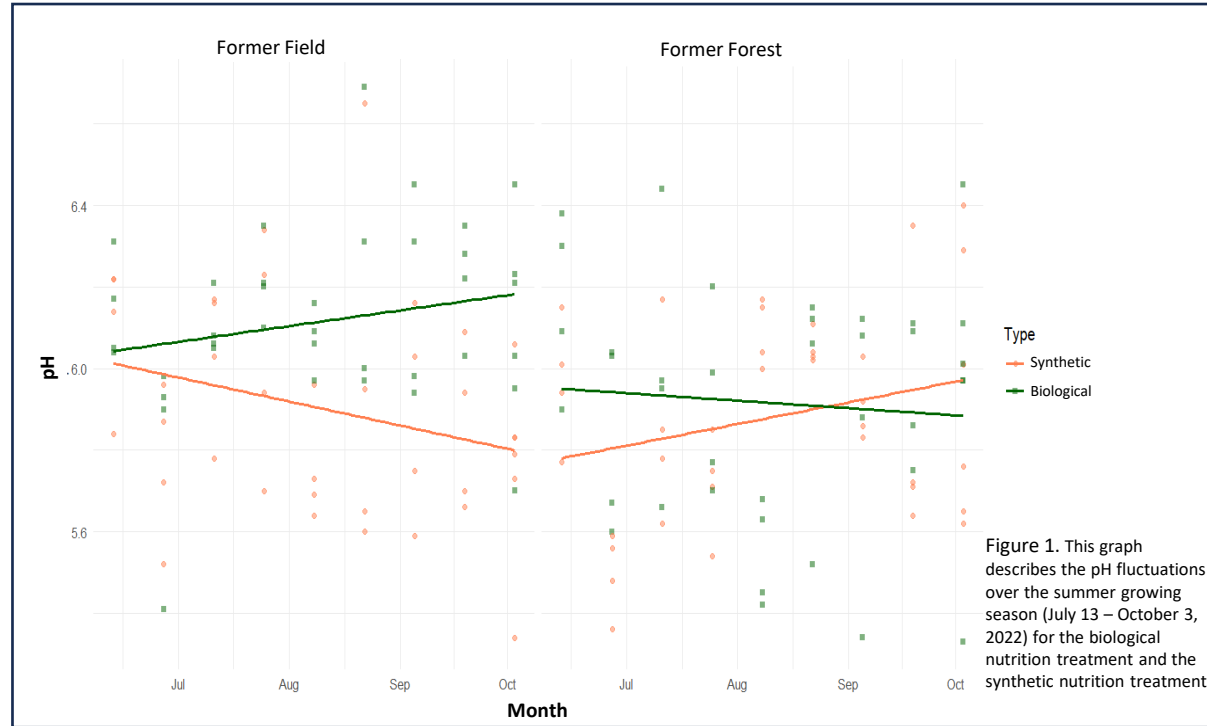


Figure 1. This graph describes the pH fluctuations over the summer growing season (July 13 – October 3, 2022) for the biological nutrition treatment and the synthetic nutrition treatment.

## Biological nutrition treatments

- No additional nutrition was added to the young vines before the initial sample date on June 13<sup>th</sup>, 2022.
- Compost treatments applied directly to the soil on June 13<sup>th</sup> and September 19<sup>th</sup>.
- Compost extracts and compost tea applied as a soil soak and foliar spray, respectively, twice a month for June and July and once in August and September.
- A total of 20lb of nitrogen were applied over three synthetic treatment dates.
- Soil assessments and samples were collected twice a month from June to September and once in early October.

## Soil collection methods

- 3-4 cores (0-15cm deep) consolidated into composite.
- 16 samples collected on the dates of biological nutrition treatments, 24 in total.
- Samples air dried, pressed through 2mm sieve.

## Protocol

- Sample batches included reference soil sample with each.
- Weighed soil (10g) into falcon tube™.
- 20 mL (0.01 M) CaCl<sub>2</sub> solution stirred into each sample.
- Additional suspension four to five times over the next 30 minutes.
- Solutions allowed to settle for 30 minutes.
- pH measured by immersing the combination electrode (Benchtop pH/mV Meter) in the supernatant solution and slowly swirled without disturbing the solids settled on the bottom.
- pH recorded when reading stabilized.

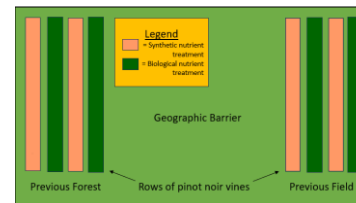


Figure 3. Represents the geographic layout of the experiment. Not to scale. Forest and field sites were converted to a vineyard simultaneously.

## Results

- In the synthetic nutrition treatments, the slope of the linear regression lines showed a decrease the pH in the former field ( $R^2 = 0.046$ ) and increase in the former forest ( $R^2 = 0.075$ ).
- Biological nutrition treatments increased pH in the former field ( $R^2 = 0.0059$ ) and decreased the pH in the former forest ( $R^2 = 0.067$ ).
- Results from a two-sample Welch's t-test initial pH of previous forest and field was not significantly different ( $p$ -value = 0.54). The initial mean pH (6.07) of the forest was slightly more acidic than the initial pH mean (6.12) for the previous field land.
- There was not significant change in the pH over time for the biological ( $p$ -value = 0.32) or synthetic ( $p$ -value = 0.94) treatment in the previous forest and the biological ( $p$ -value = 0.71) treatments of the previous field. Accept the null hypothesis for these treatments.
- There was a significant difference in the final and initial pH for the synthetic treatment ( $p$ -value = 0.033) in the previous field. Reject the null hypothesis for this treatment.
- Both treatments did not affect the pH beyond the recommended range for pinot noir grape vines.
- The synthetic nutrition treatments increased the pH for the previous forest and decreased the pH in the previous field.
- There is an intercepting point of the linear regression lines for the treatment types in the former forest.

## Discussion

- Unmeasured variables in soil biology from the previous field and previous forest will host fungi and bacteria from the old ecosystem<sup>3</sup>.
- Treatments provide nutrients to multiple aspects of soil biology, each of which will have its own contribution to the overall pH.
- Multiple studies show responses to biological and synthetic fertilizer differ under different land use, crop type, length of the study and other factors<sup>4,5</sup>.
- Due to the recent conversion of both vineyards, the ecosystems could be in a state of flux. Causing disturbances in the soil biology as the systems adjust. This could be contributing to the range of variation in the  $R^2$  values (0.069) of the synthetic and biological treatment for the former field.

## Conclusion

One potential explanation for the distribution of the data, is that the initial soil structure of the vineyards differ in the associated microbiology that are acting as a significant influence on the pH in flux with the nutritional amendments. A continuation of the experiment could potentially demonstrate the pH fluctuations are attributable to the recent conversion of the land.

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