Ferrington Vineyard Field Trial Highlights

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Summary Paper

In California, most precipitation occurs in the winter, and in the North Coast region, vineyard managers frequently plant cover crops or allow naturalized vegetation to grow in vine middles (strips between vine rows) during winter months. Vineyard managers choose these plant cover systems based on many factors including cost, convenience, and the potential for competition with vines for water and soil nutrients. These systems also have the potential to change soil health, impacting the soil's organic matter content, structure, nutrient cycling, water infiltration and storage, and erosion potential. In Boonville, in California's North Coast vineyard region, a replicated field demonstration compared commonly used plant cover systems (PCS) that differ in tillage requirements and plant cover. The PCS used were; a high biomass cereal/legume green manure cover crop, incorporated in the spring (TCC), a no-till annual reseeding grass/legume cover crop (NTCC) managed with mowing, an alternate row system with the above two systems in every other row (ARCC), naturalized vegetation managed no-till with mowing (NTNV), and naturalized vegetation tilled annually (TNV). The systems with tillage; TCC, TNV, and every other row of ARCC, were mowed once and required 3-4 annual passes with a disc to incorporate the cover crop in spring and prepare the fall seed bed. The no-till systems, NTCC, NTNV, and every other row of ARCC, were mowed four times annually.



Figure 1. Cover crop seeding, fall 2015.

The vineyard in this trial had been managed with an annually incorporated green manure cover crop for the seventeen years since planting at the time the trial was initiated. Vine water status was monitored using a pressure chamber, and vine yields and pruning weights were measured three times during the

six-year demonstration. Compaction to 24" was measured in two of the PCS treatments 6 and 18 months after the trial start. Water infiltration rates were compared for the different PCS 2 and 3.5 years after the trial started. Infiltration rates were also compared spatially, in the vine row, tire tracks, and middles within one plot on two dates. Sampling (0-6") for soil health properties, including water stable aggregates, bulk density, total carbon and nitrogen, permanganate oxidizable carbon (POX C), mineralizable carbon (min C), and potentially mineralizable nitrogen (PMN) was conducted 2.5 and 5.5 years after starting the demonstration. Soil samples from the vine rows, which are maintained bare using herbicides, were also collected on the later sample date.

Trial Results Highlights

- The plant cover systems did not have a differential influence on vine water status, yield, and pruning weights.
- Soil compaction occurred in tractor tire tracks. It is not known whether the measured level of compaction impacts vine root growth, and compaction is likely to be vineyard specific, depending on soil texture, traffic patterns, and other factors.
- Water infiltration rates were lower under the vines and in the tire tracks compared to the middles.
- Soil health tests with the greatest sensitivity to plant cover systems after five years were:
    - water stable aggregates, showing a trend toward greater water stable aggregates in no-till than tilled plant cover systems, and
    - mineralizable carbon, 96 hour rate, with higher rates in tilled than no-till plant cover systems.
- After 20 years of herbicide use and no-till in the vine rows compared to cover crops in the middles, soil health and function were impacted in several ways:
    - Vine rows had reduced soil organic matter (measured as total carbon), water stable aggregates, and infiltration rates, indicating a reduced capacity for water entry and storage compared to middles.
    - The combination of reduced water stable aggregates, slow infiltration, and lack of plant cover contribute to a greater risk of soil erosion in vine rows compared to middles.
    - Biological activity, nutrient cycling, and nitrogen supply from organic matter were reduced in vine rows to a greater extent than total soil organic matter. While total soil carbon was reduced approximately 20% in vine rows compared to middles, mineralizable C and potentially mineralizable nitrogen were 40-45% lower in vine rows than middles.

2024-2025 Update

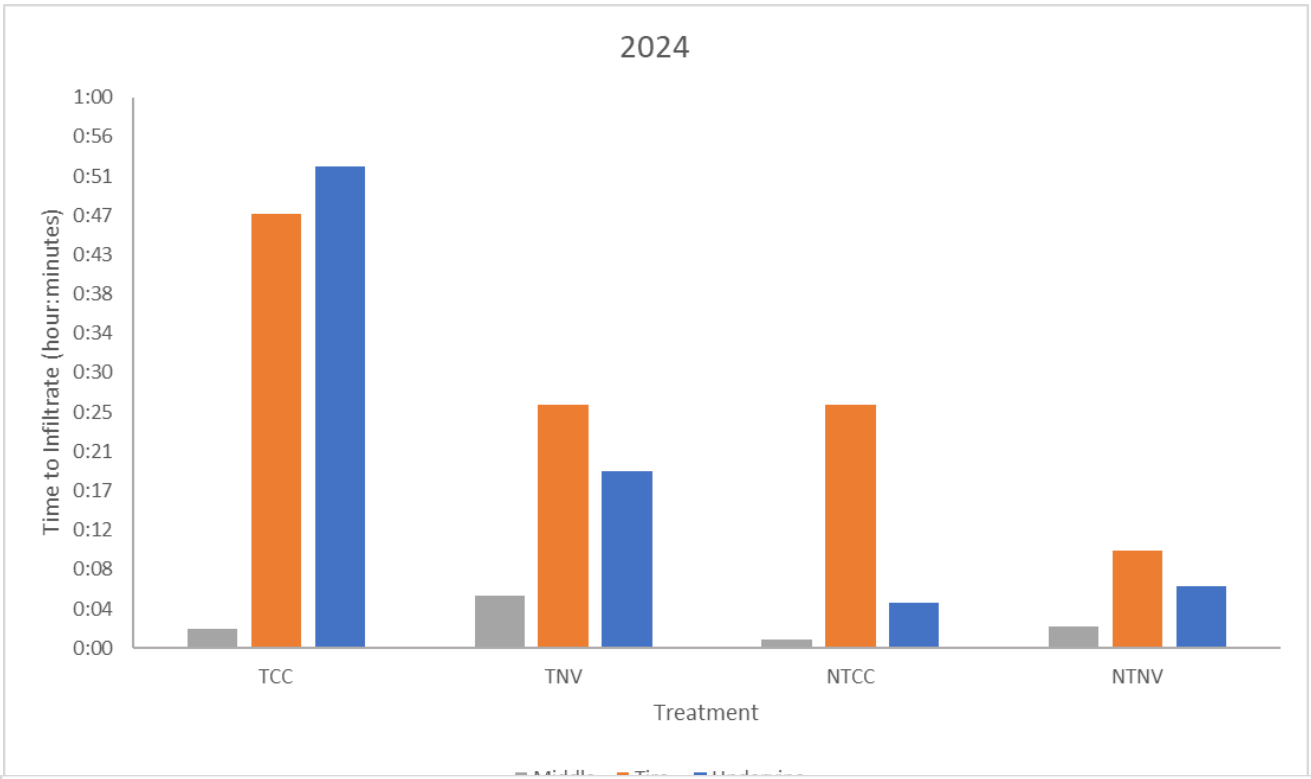
Following the initial summary of the trial from 2015 through 2022, Ferrington Vineyard and the Mendocino County RCD have been able to continue implementation of the trial, with another two rounds of data collection in Spring 2024 and 2025. Data collection included in-field assessments of compaction and water infiltration, and collecting 24 soil samples each year for Oregon State University's complete soil health lab assessment (pH, EC, Organic matter, CN, NO3-N, P, K, Mg, Ca, texture, potentially mineralizable N, active carbon, wet aggregate stability, respiration). The full dataset is available upon request with MCRCD. All soil samples were taken from the same vineyard rows each year, as well as for field readings. Infiltration tests were conducted across a single row of each cover system, while the compaction results shown are an average of readings across three rows for each system. The ARCC cover system was not continued after 2022 for management reasons, and so there are only 4 comparisons (NTCC, TCC, NTNV, TNV). In the former ARCC system area, half of the rows now remain managed permanently as TCC, and the other half remain as NTCC.

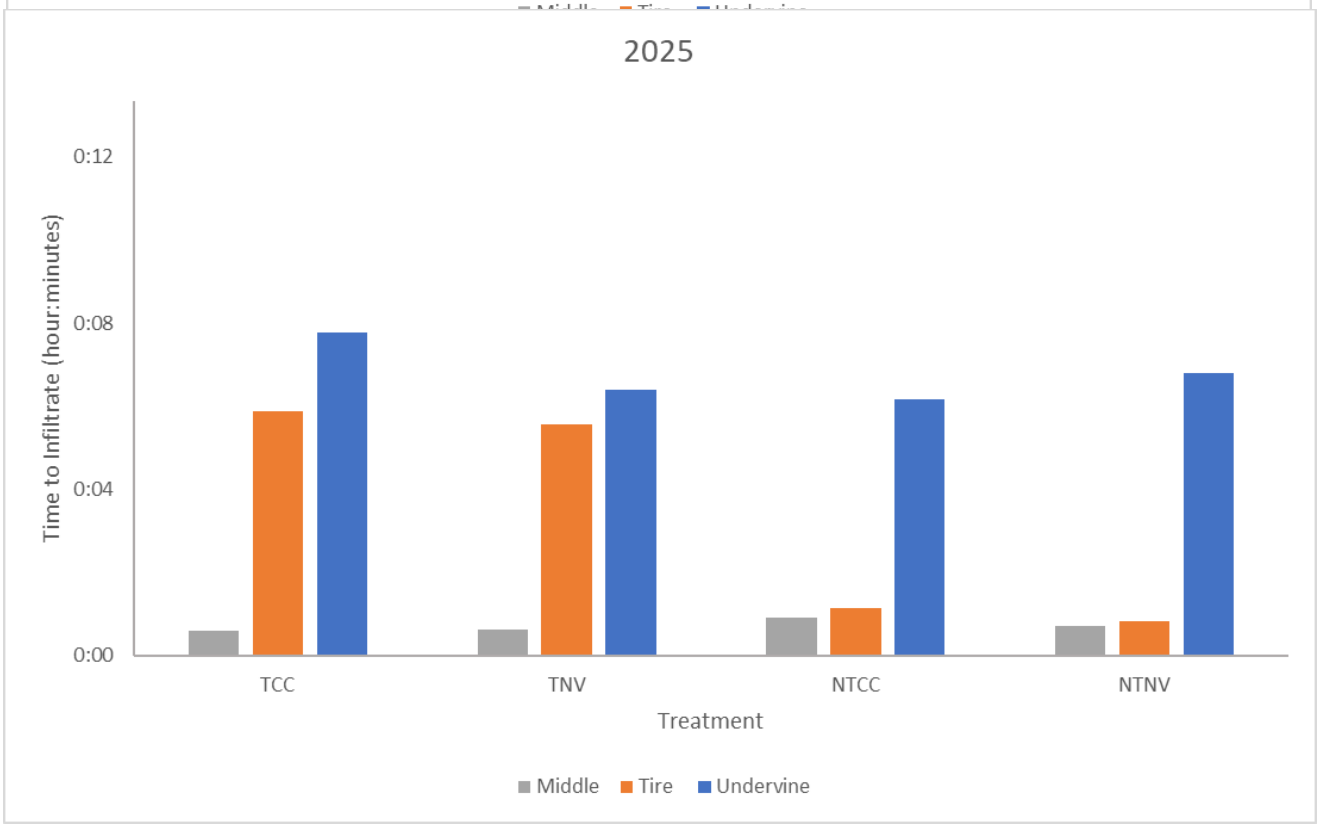
The results of the most recent field data collection and lab analysis are summarized below, and include visualization of the 2024-2025 data.

Generally, a trend in the lab data can be seen that soil health metrics are higher under covered alley soil, be that cover crop *or* naturalized vegetation, than in bare soil under the vine. As seen in the data for potassium and magnesium, however, some nutrients are higher in bare soil than under a cover crop at the time of sampling. This may be due to faster release from organic matter and increased exposure to mineral weathering processes, as well as reduced availability of certain nutrients from cover crop uptake. However, under a cover crop, nutrients are more likely to be retained and built long-term, and are less prone to loss through erosion or leaching.

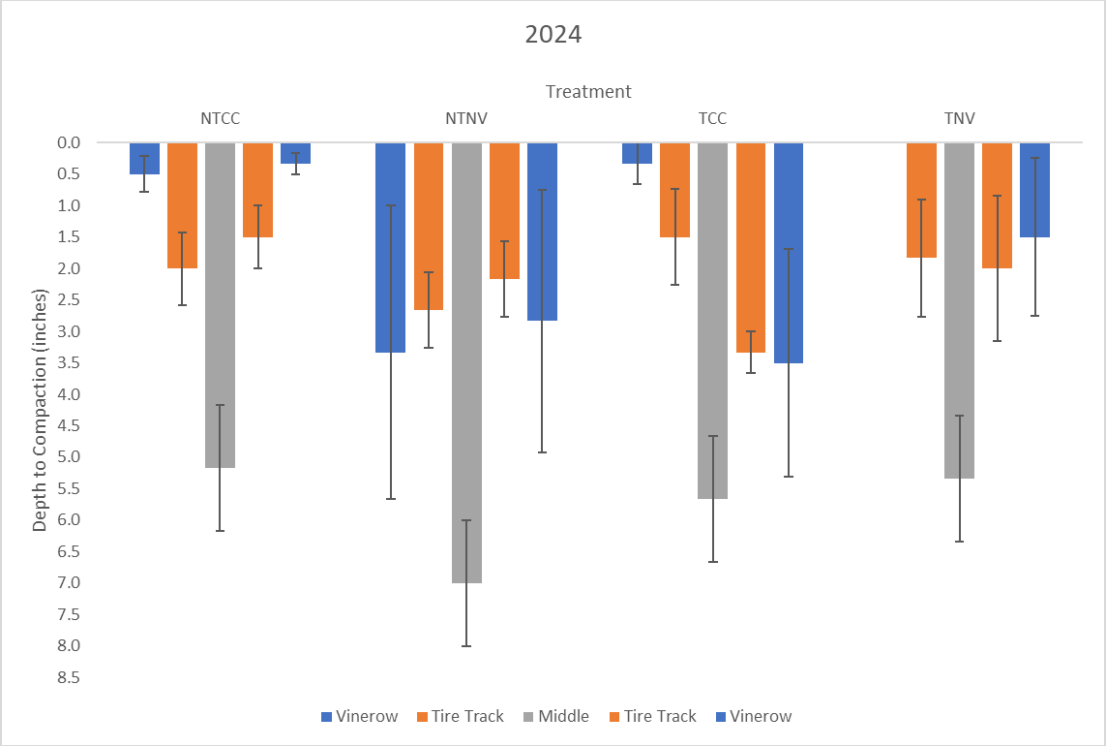
For compaction testing, a consistent result across the entire project lifetime that can be seen in the summary graphs is that the middle of the vineyard row is by far the least compacted, compared to both equipment/tire lanes and directly under the vine. With 3 exceptions out of 16 comparisons in 2024-2025, tire lanes have been less compacted than the bare under-vine soil as well. This compaction may play a role in the observed infiltration rates throughout the project, where water infiltration is significantly higher in the row middle, compared to tire tracks and bare under-vine soil. Comparing the tire lane infiltration rates in 2024 and 2025, tire lanes in tilled cover systems showed a lower rate (more time) than the no-till tire lanes.

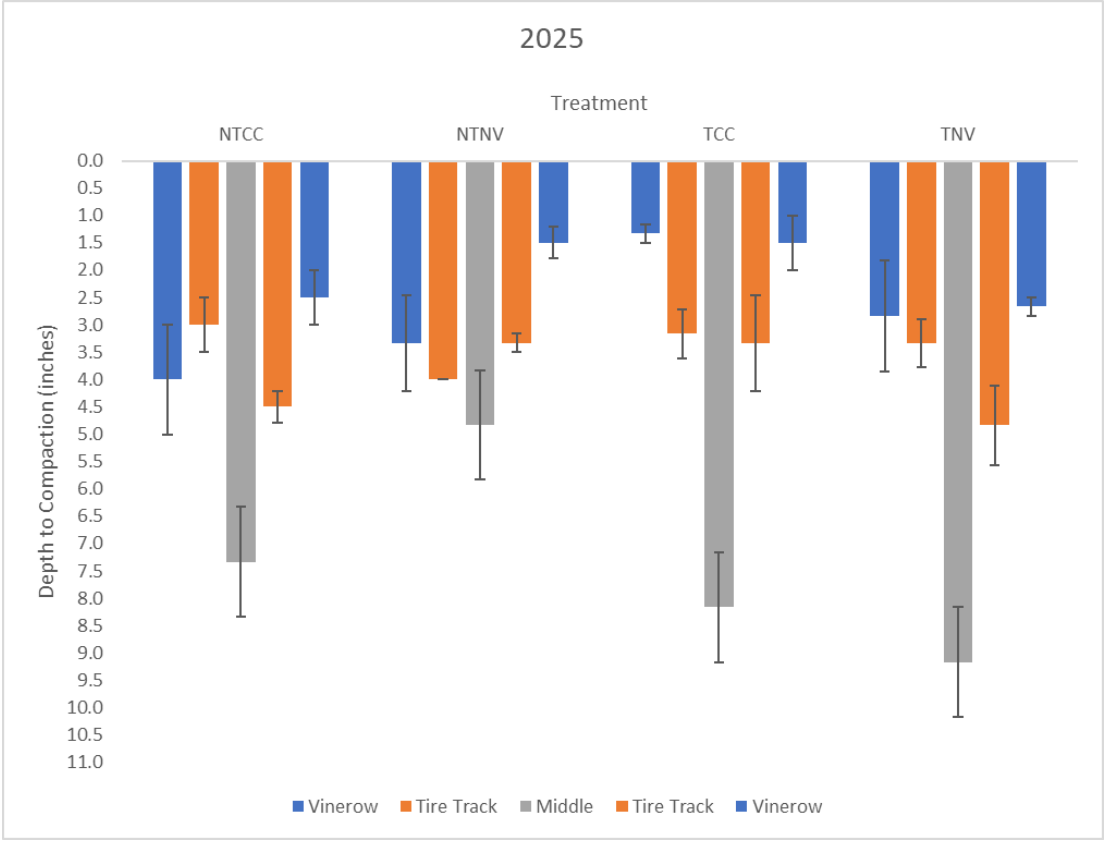
Infiltration



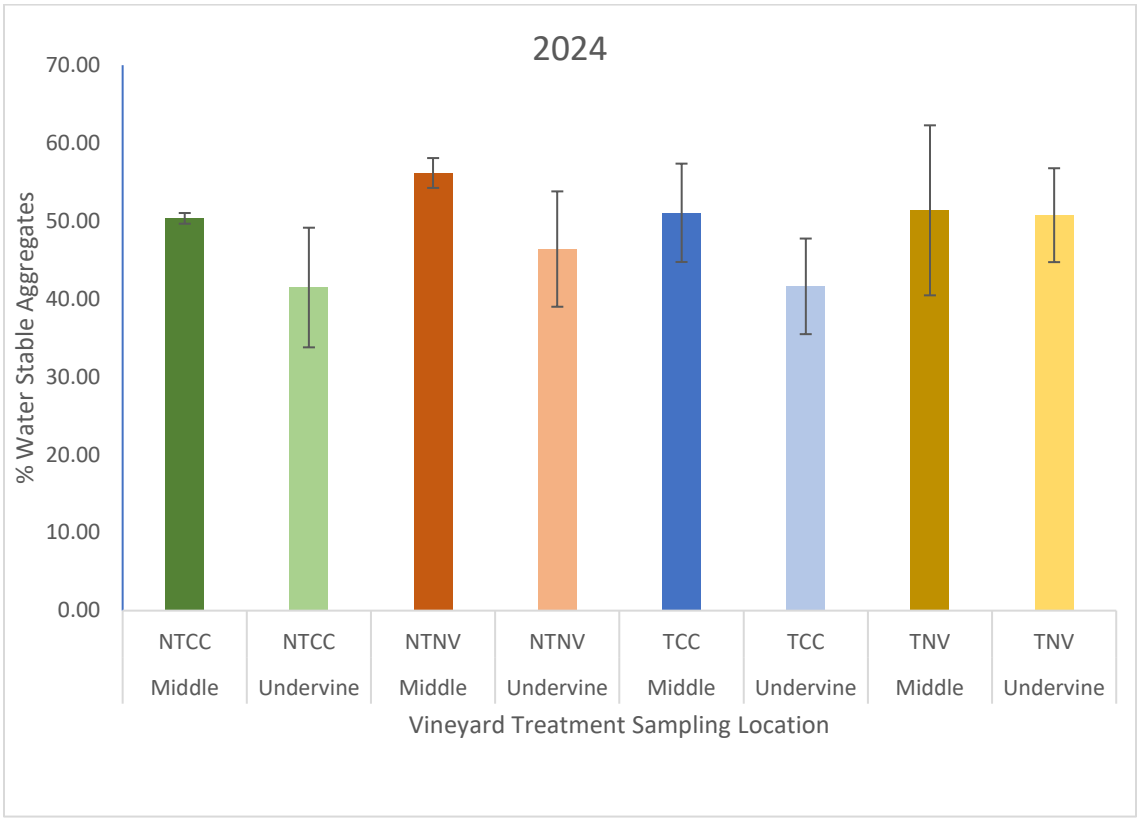


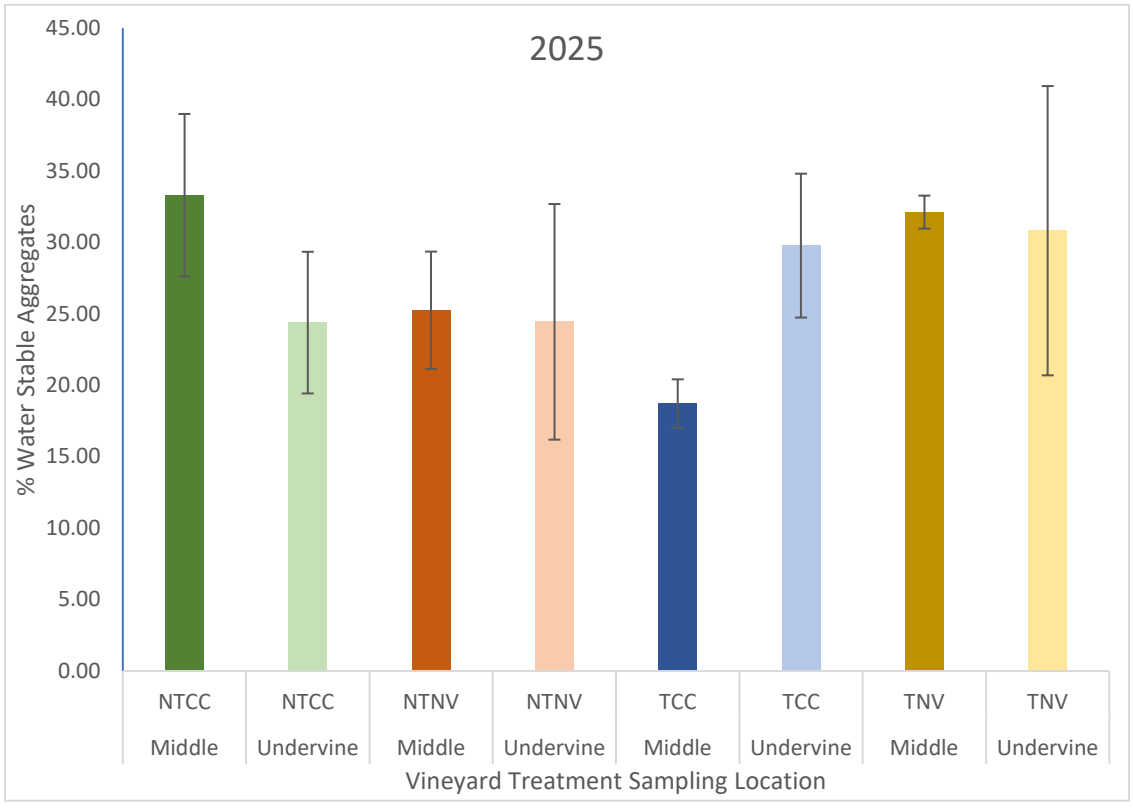
Compaction


2024
Treatment
NTCC
NTNV
TCC
TNV
Depth to Compaction (inches)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
8.5
Vinerow
Tire Track
Middle
Tire Track
Vinerow

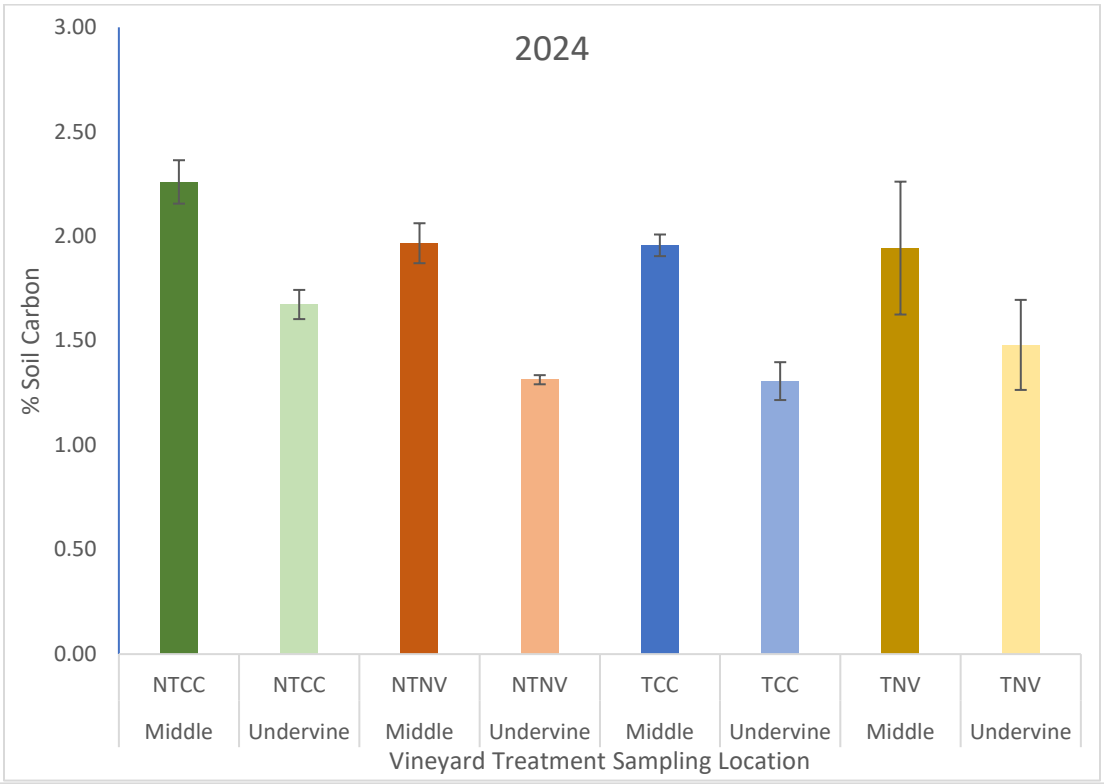

2025
Treatment
NTCC
NTNV
TCC
TNV
Depth to Compaction (inches)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
8.5
9.0
9.5
10.0
10.5
11.0
Vinerow
Tire Track
Middle
Tire Track
Vinerow

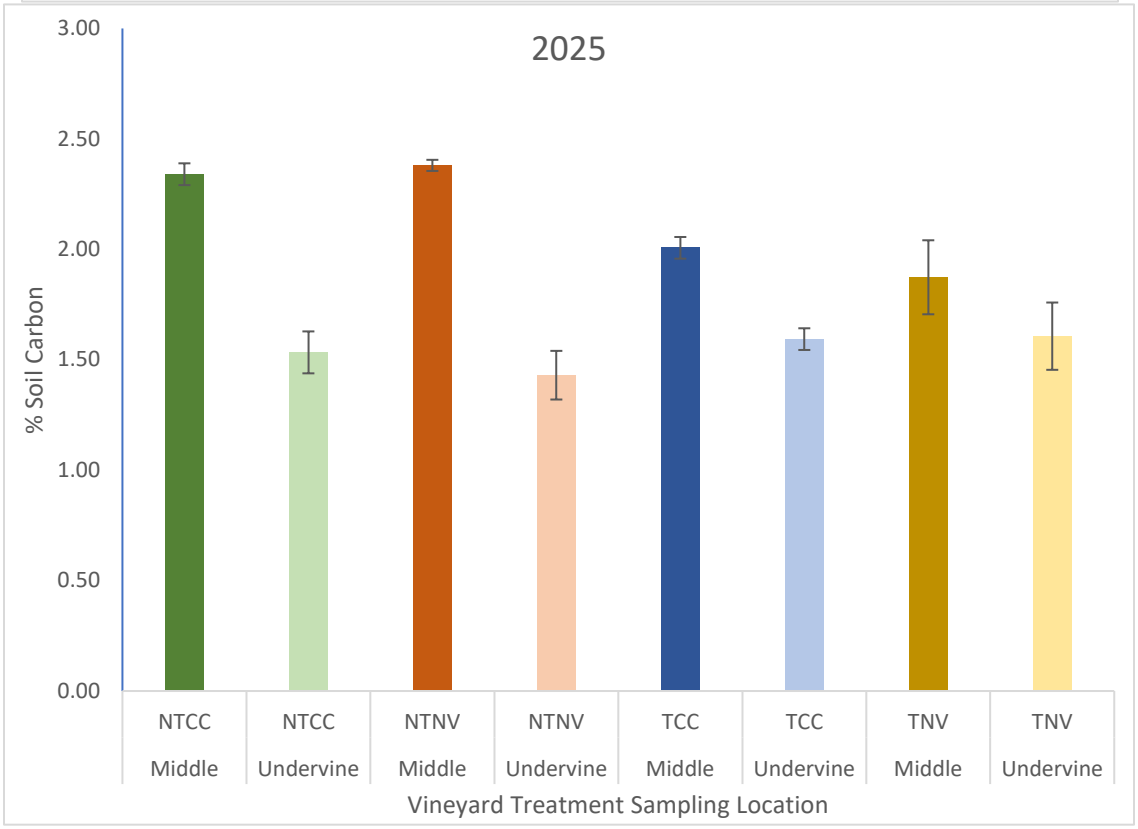
Water Stable Aggregates



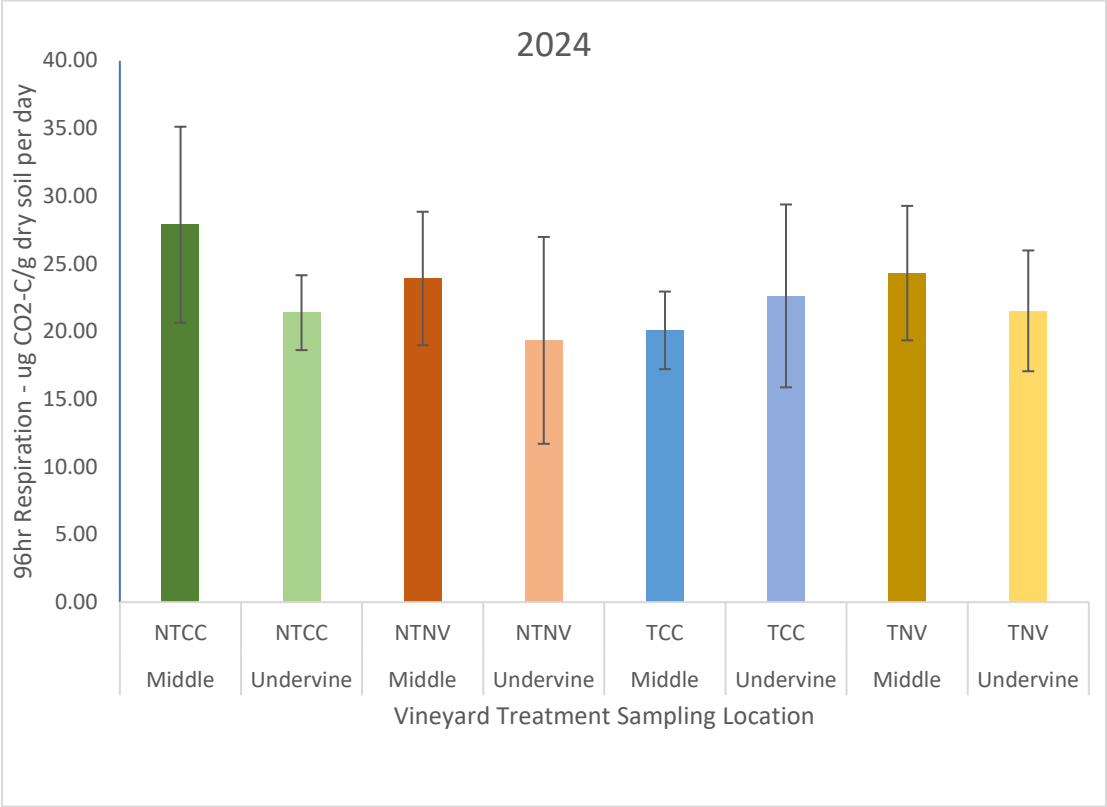


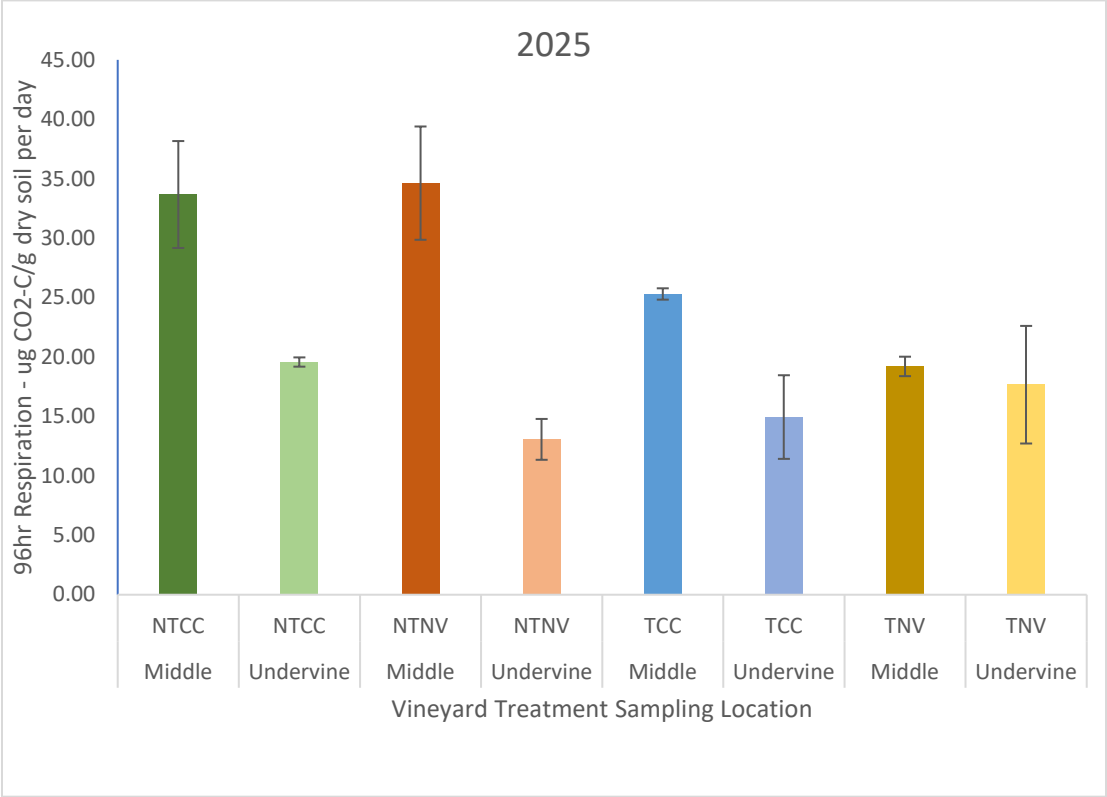
% Carbon


2024
3.00
2.50
2.00
1.50
1.00
0.50
0.00
% Soil Carbon
NTCC Middle
NTCC Undervine
NTNV Middle
NTNV Undervine
TCC Middle
TCC Undervine
TNV Middle
TNV Undervine
Vineyard Treatment Sampling Location

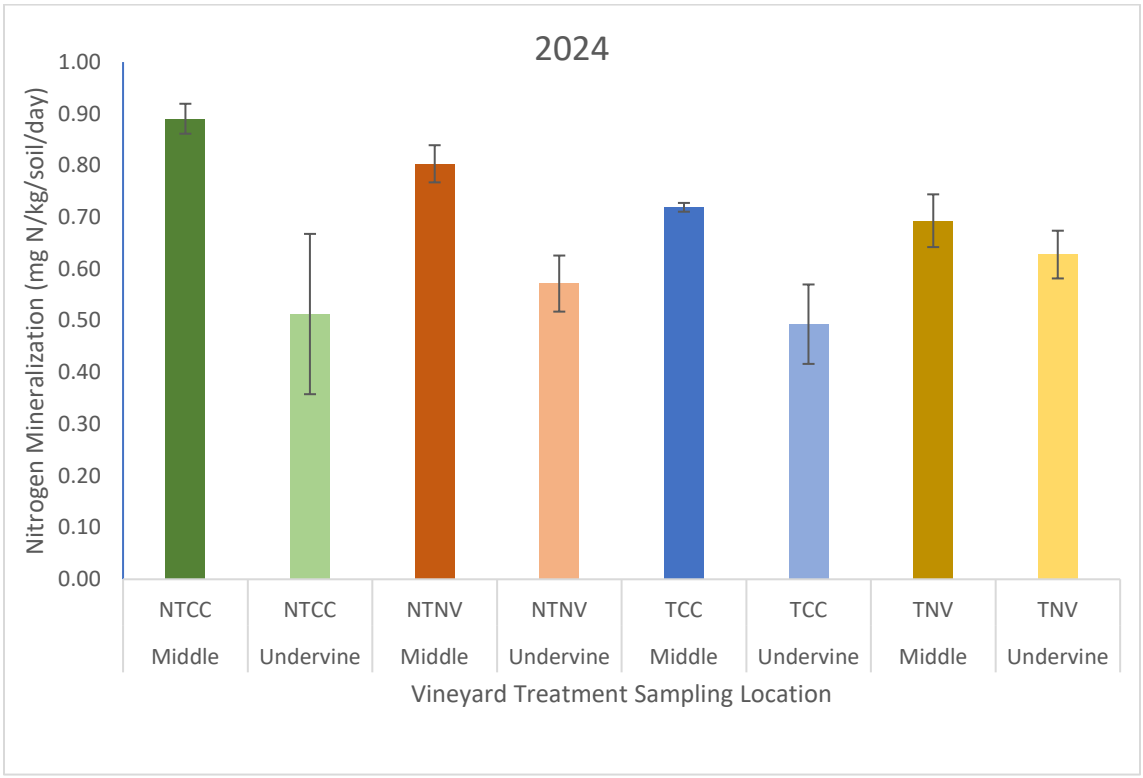

2025
3.00
2.50
2.00
1.50
1.00
0.50
0.00
% Soil Carbon
NTCC Middle
NTCC Undervine
NTNV Middle
NTNV Undervine
TCC Middle
TCC Undervine
TNV Middle
TNV Undervine
Vineyard Treatment Sampling Location

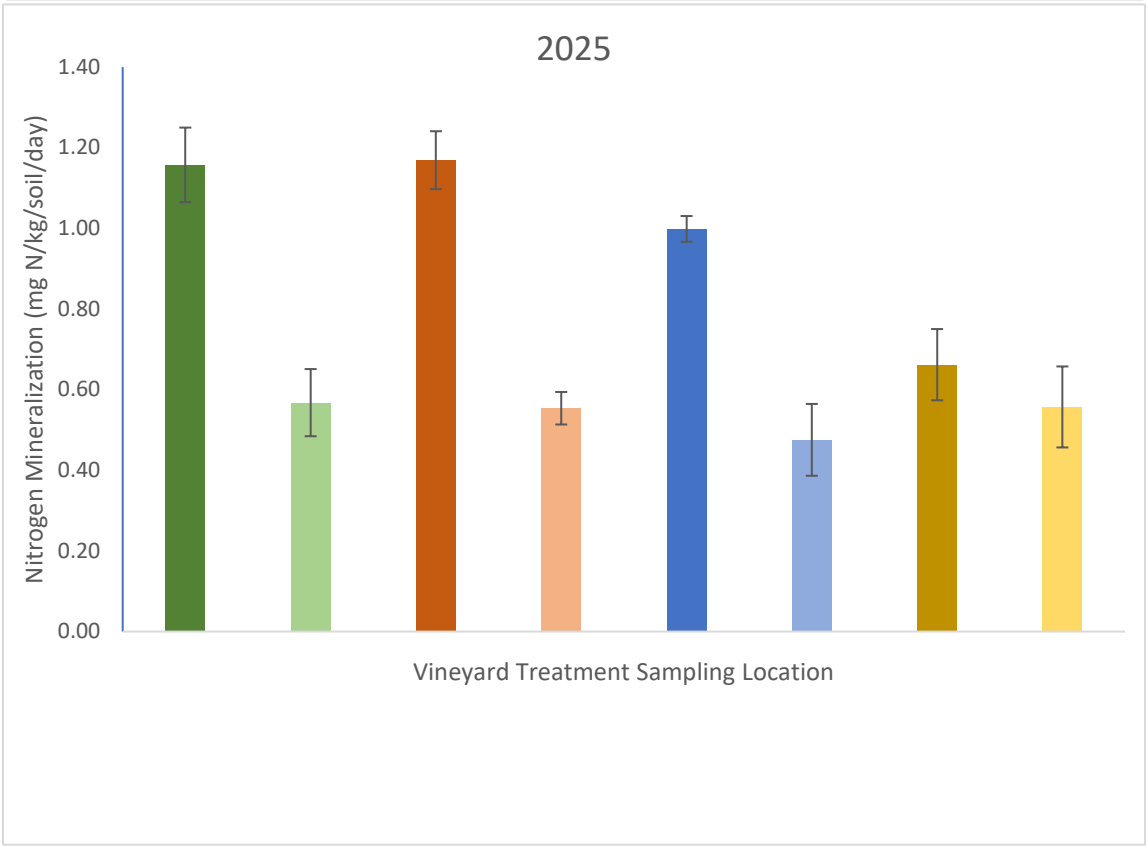
Microbial Respiration



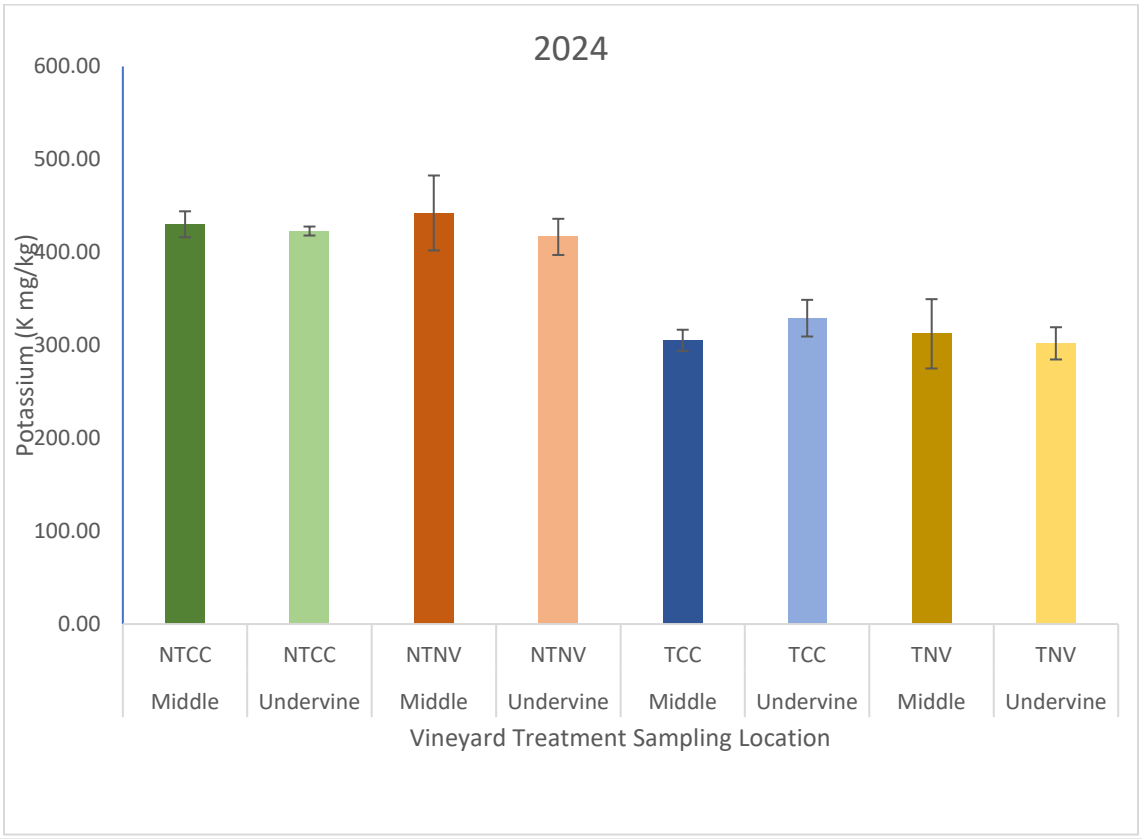


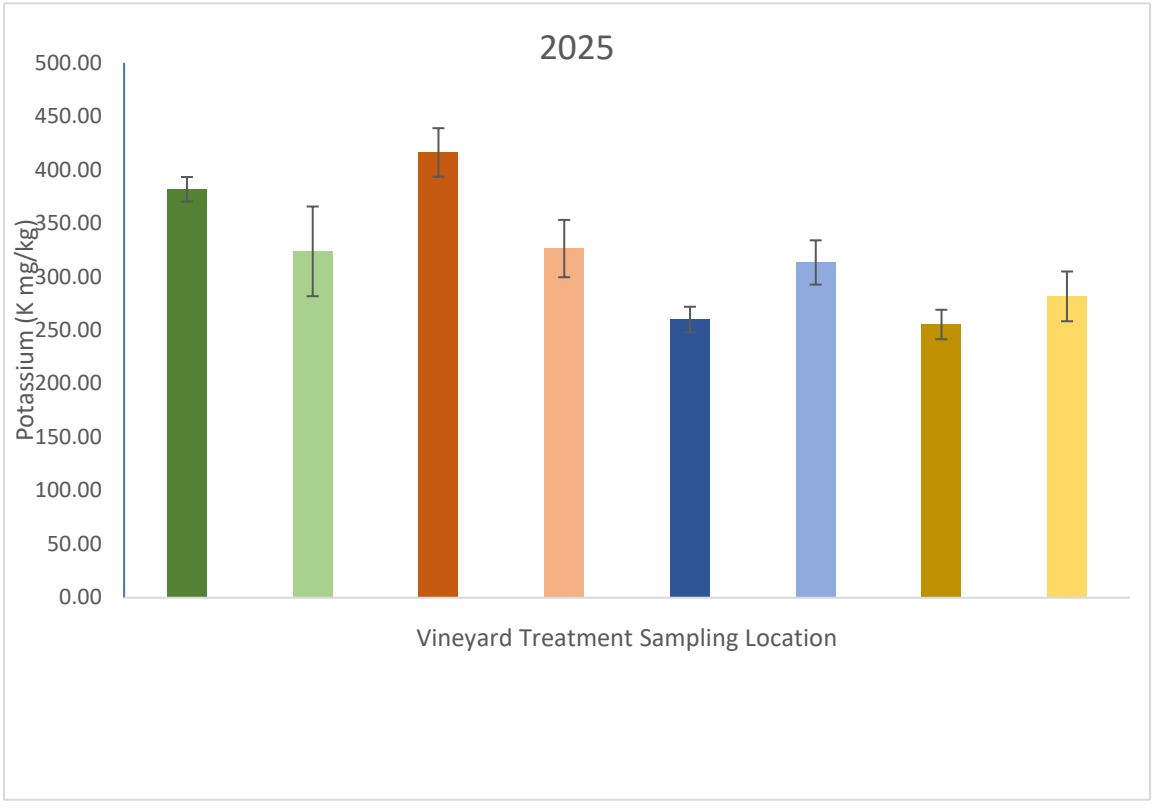
Nitrogen Mineralization



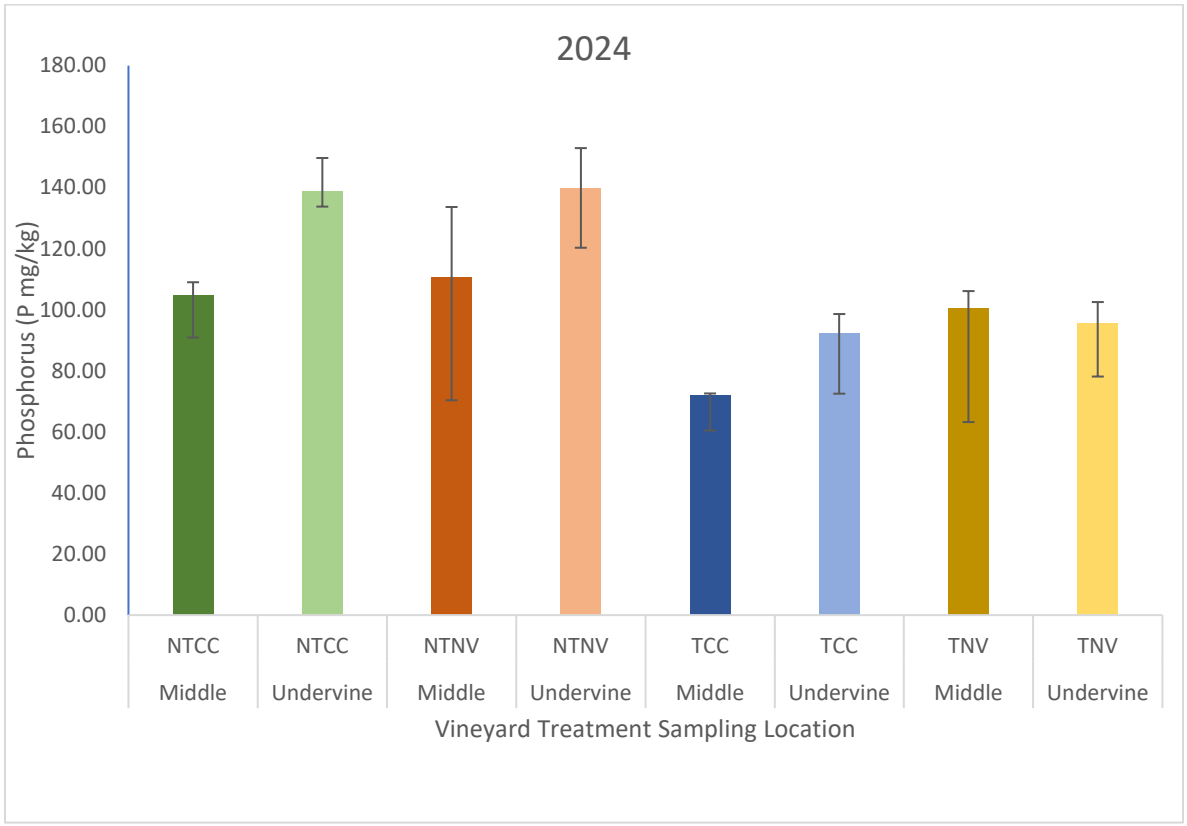


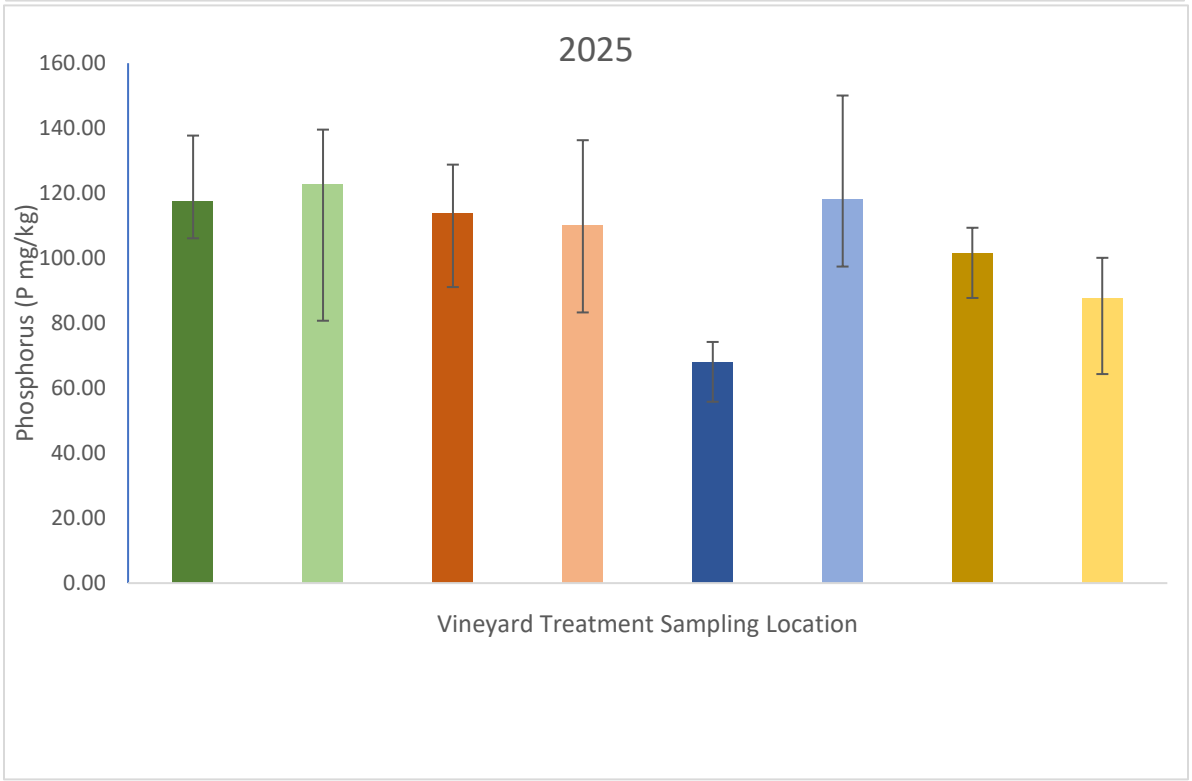
Potassium


2024
600.00
500.00
400.00
300.00
200.00
100.00
0.00
Potassium (K mg/kg)
NTCC Middle
NTCC Undervine
NTNV Middle
NTNV Undervine
TCC Middle
TCC Undervine
TNV Middle
TNV Undervine
Vineyard Treatment Sampling Location

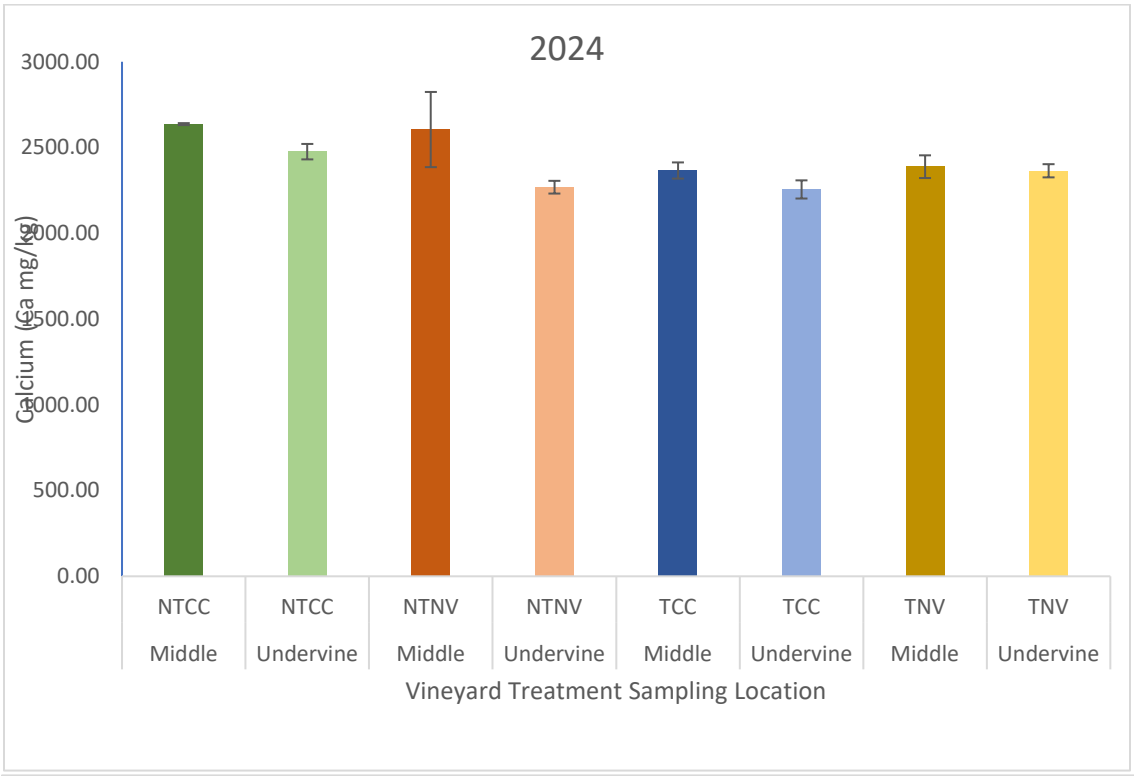

2025
500.00
450.00
400.00
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
Potassium (K mg/kg)
Vineyard Treatment Sampling Location

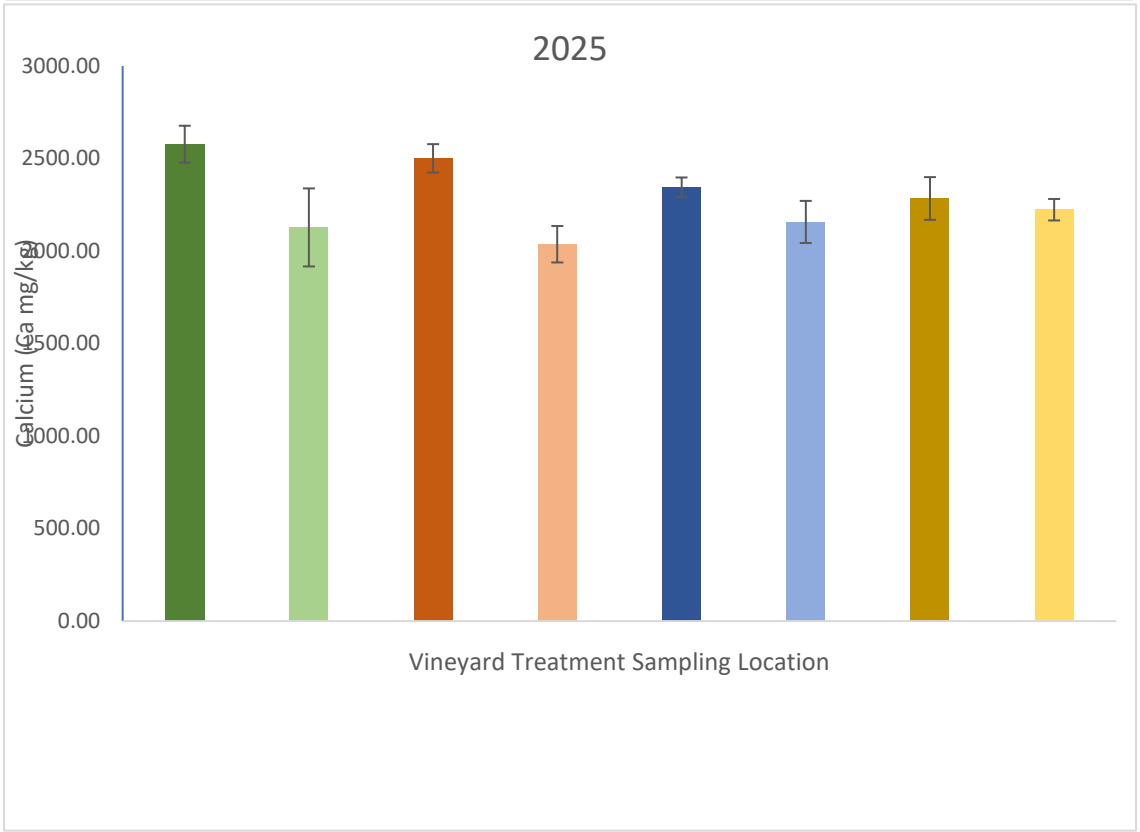
Phosphorus


2024
180.00
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
Phosphorus (P mg/kg)
NTCC Middle
NTCC Undervine
NTNV Middle
NTNV Undervine
TCC Middle
TCC Undervine
TNV Middle
TNV Undervine
Vineyard Treatment Sampling Location

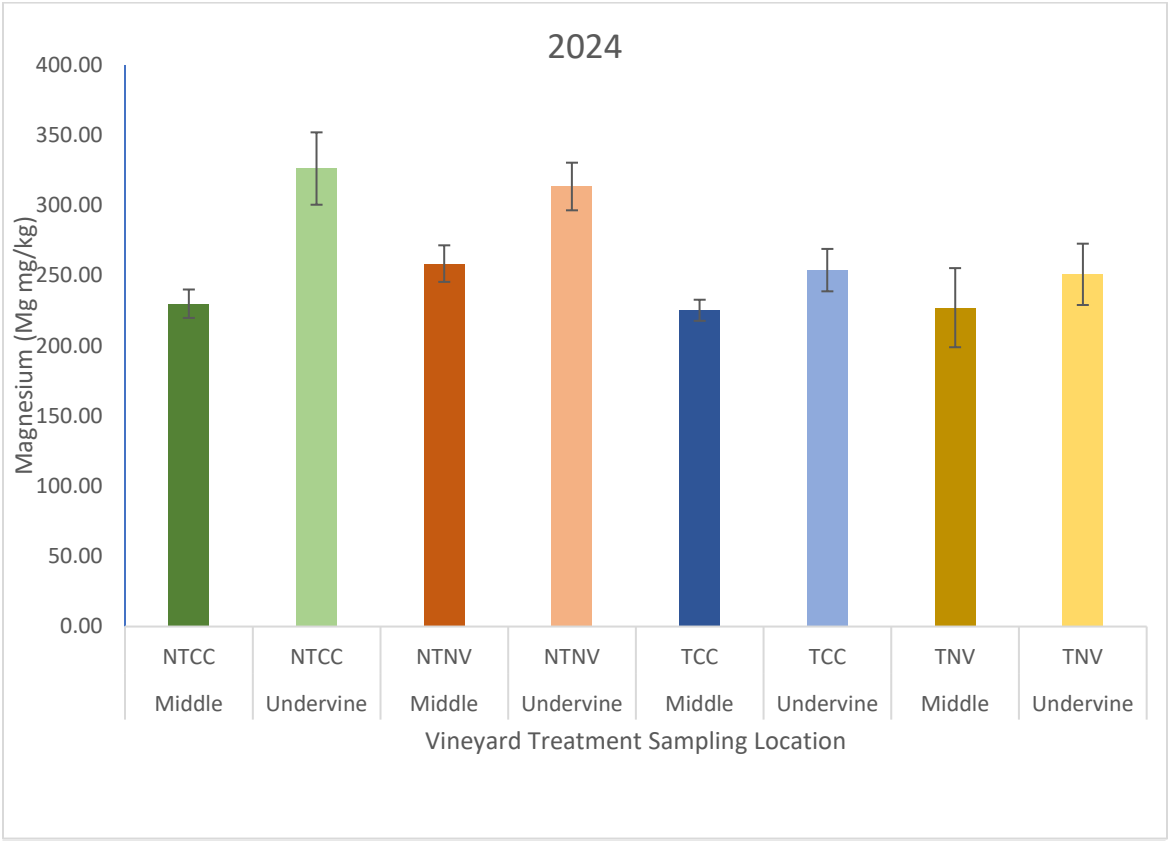

2025
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
Phosphorus (P mg/kg)
Vineyard Treatment Sampling Location

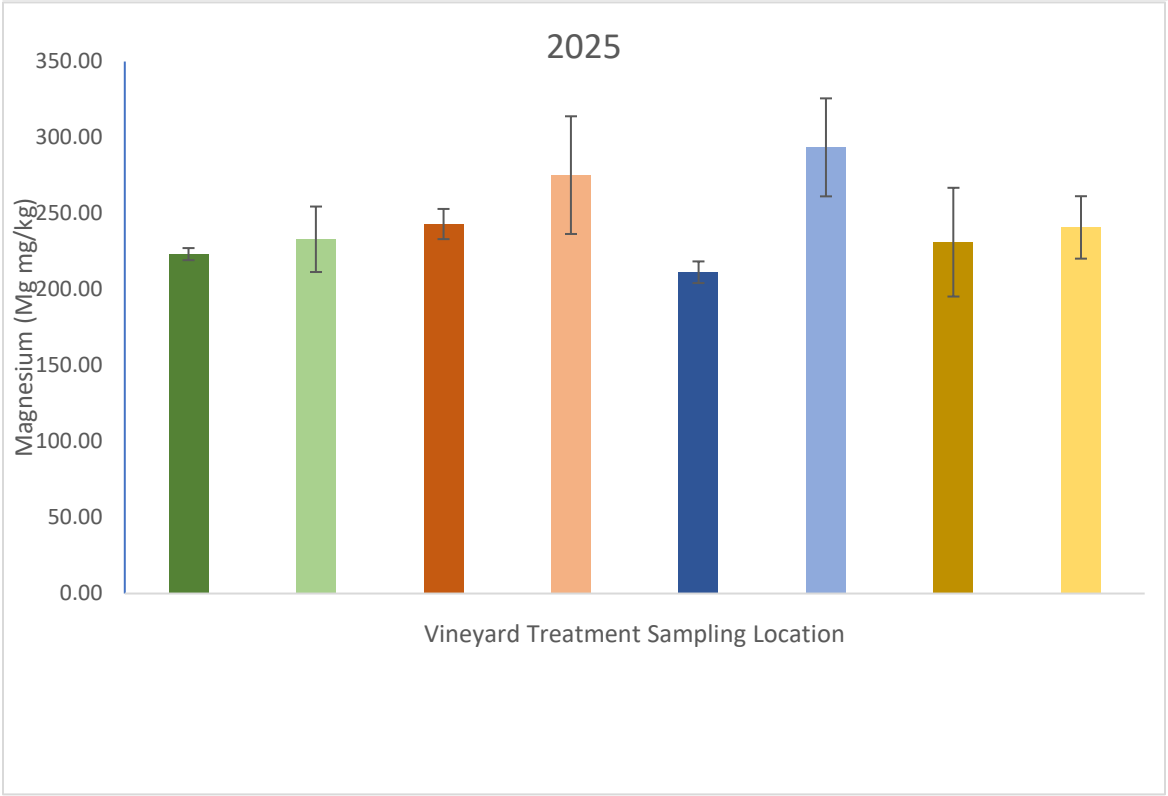
Calcium


2024
3000.00
2500.00
2000.00
1500.00
1000.00
500.00
0.00
Calcium (Ca mg/kg)
NTCC Middle
NTCC Undervine
NTNV Middle
NTNV Undervine
TCC Middle
TCC Undervine
TNV Middle
TNV Undervine
Vineyard Treatment Sampling Location


2025
3000.00
2500.00
2000.00
1500.00
1000.00
500.00
0.00
Calcium (Ca mg/kg)
Vineyard Treatment Sampling Location

Magnesium


2024
400.00
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
Magnesium (Mg mg/kg)
NTCC Middle
NTCC Undervine
NTNV Middle
NTNV Undervine
TCC Middle
TCC Undervine
TNV Middle
TNV Undervine
Vineyard Treatment Sampling Location


2025
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
Magnesium (Mg mg/kg)
Vineyard Treatment Sampling Location