

OPTIMIZING LIME APPLICATION RATES TO IMPROVE CANOLA PERFORMANCE IN ACIDIC SOILS

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INTRODUCTION

Soil acidification is an increasingly serious issue, affecting nearly 40% of the world's arable land. This phenomenon is driven by the prolonged usage of nitrogen (N) fertilizers and other anthropogenic activities. The application of N fertilizers leads to an increase in hydrogen (H⁺) ions in the soil leading to a lower pH. H⁺ ions are added into the soil in the form of ammonia (NH₄) in N fertilizers. The conversion of ammonia to nitrate (NO₃)⁻ lead to the discharge of H⁺ ions producing the acidity found in soil (Mohammed et al., 2021). Lower pH levels result in poor root development and plant growth due to the increased solubility of toxic metals such as aluminum (Al) and manganese (Mn).

In addition to increased solubility of toxic metals, soil acidification also leads to leaching, which includes Na, Ca, Mg and K. Leaching of beneficial cations and increased solubility of toxic metals further reduce the soils' ability to maintain plants. These changes raise the difficulty of absorbing nutrients and water leading to severe injury of the roots, reduction in crop yield, and increased susceptibility to pathogens (Yadav et al., 2020). Furthermore, when the soil pH is less than 5.5, it renders phosphate (P) unusable to plants, another critical nutrient.

Lime (CaCO₃) is commonly used on agricultural land due to its neutralizing effects. One useful metric in assessing soil health is base saturation percentage (BS%). BS% calculates the number of cations that are available for exchange in the soil (Na⁺, Ca⁺, Mg²⁺, and K⁺) relative to the soil's cation exchange capacity (CEC). BS% increases as the pH increases, which correlates with improved nutrient availability, better soil structure, and enhanced biological activity.

This study focuses on evaluating lime application rates (t/acre) to best optimize plant productivity and crop yield of Canola (*Brassica napus*) plants from cultivars *Empire* and *Industrious*. The experiment was conducted using acidic soil with a pH of 4.5 collected from Rockford, WA. The canola plants were treated with 6 different lime application rates: includes 0 (control), .5, 1, 2.5, 5, and 10 t/acre each applied in a triplicate.

MATERIALS AND METHODS

The soil was collected from Rockford, WA on October 11, 2024, and had an initial pH of 4.5. The soil was air dried and then passed through a 2-mm sieve prior to using it.

- Canola cultivars *Empire* and *Industrious* were planted in a triplicate for the following six lime treatments: 0 (control), .5, 1.0, 2.5, 5, 10 t/acre (T0-T5)
- Each pot contained 2.6 kg of soil.
 - Lime was applied 2 weeks prior to the experiment to adjust the soil pH as part of the incubation process.
 - Sulfur (N) and boron (B) were applied one week prior to planting and N was applied midway through the experiment.
- Upon maturation, the plants were harvested by cutting them at the base of the stem and brought to the lab. The following measurements were recorded:
 - Aboveground plant mass
 - Number of pods
 - Mass of seeds
- After collecting all the aboveground data, the roots were extracted from the soil. The pots were moistened for 2 days to loosen the soil and improve root recovery.
 - The roots were washed, dried and weighed to determine the dry root mass.



Figure 1: These roots were being left to dry to get their dry mass. It was necessary to wash them prior to weighing due to the organic matter presented in the roots.

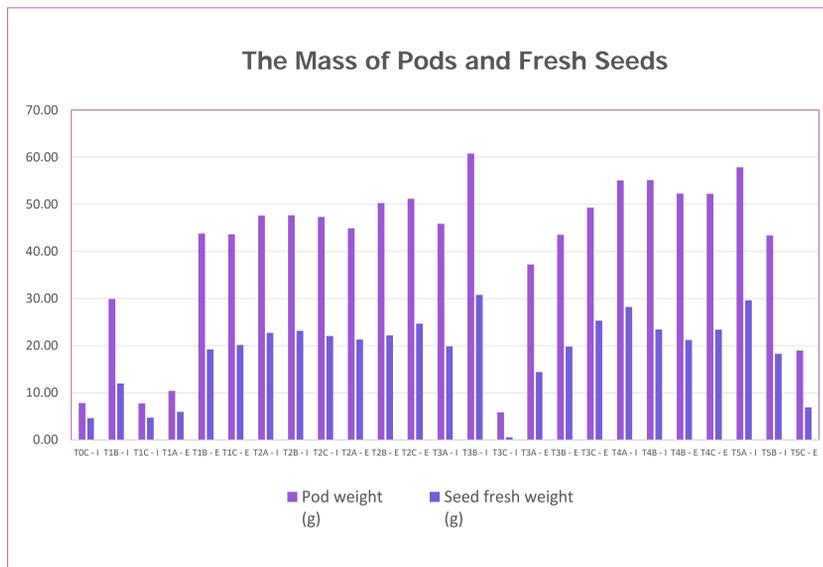
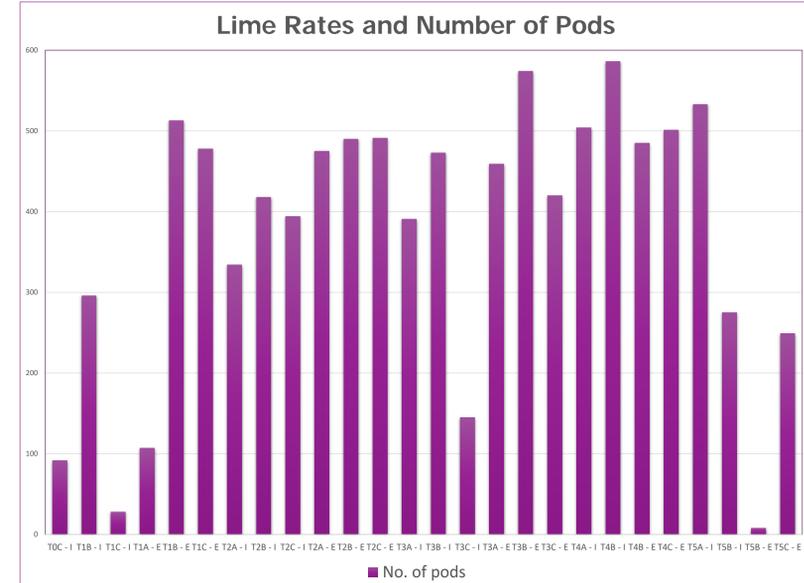


Figure 2 : Here we are taking the soil from the pot and separating the roots from the soil. We took the dry biomass of the roots, and the soil was sent for analysis at Moses Lake, WA.



PRELIMINARY CONCLUSION

Based on visual observations, moderate lime application is the most beneficial for soil health and canola plant development. The roots from lime applications T1B-E to T3B-E exhibited the best root systems. The mass and length were visibly larger than those of plants with lower or higher lime rates. Whereas for the other treatments, the roots were smaller and thinner.

With regards to pod production, plants T1B-E to T5B-I had an average of 476.5 pods per plant. Excluding plants T4C-I and T4A-E because these plant died prematurely and therefore didn't produce pods. The surviving plants also had healthier seeds for oil production. The seeds were fully matured and would be removed easily from the pods. For the plants that matured later, some of the seeds were still green and had some cotton-like substance on them indicating their lack of full development.

Soil samples have been sent to Moses Lake, WA for analysis. The results from this analysis will aid in finding which lime rate application is the best for plant performance and crop yield. These results will also let us assess the improvements to the soil health.



Figure 3: This image shows the process of counting pods. They are in piles of 25, except for the last one, and I would count all the piles once I finished picking the pods off the canola plant.

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INTERESTING FACTS

- "When removing the roots from the pots, a lot of the finer root hairs were lost due to how compact the soil became".
- "To count the number of pods I would count and put them into piles of 25. This way I wouldn't count too high and lose the number that I was at".
- "Initially we wanted to count the number of seeds for the plants, but this became unattainable".
- "The first plant that I started counting seeds for had about 700 seeds in only about a quarter of the container".