Effect of soil compactness on the total gross growth of Brassica rapa

Abstract

Soil compaction is a critical physical constraint affecting plant growth and agricultural productivity. This study investigates the relationship between varying levels of soil compactness and the total gross growth of Brassica rapa (fast plant), a model organism commonly used in botanical research. B. rapa plants were cultivated under controlled conditions in substrates with three different compaction levels: loose, moderately compacted, and highly compacted soil. Growth parameters including total plant height and leaf count were measured over a standardized growth period. At the end of the study, the roots were also evaluated.

Introduction

Soil compaction is a major problem for plant growth in farming and research. When soil gets compressed, there's less space for roots to grow, water to move through, and air to reach the roots. This can slow down plant growth significantly.

Brassica rapa (fast plant) is a great plant for experiments because it grows quickly and is easy to study. We wanted to find out how different levels of soil compaction affect plant height and leaf growth. We tested four conditions: no compaction (control), aerated soil with extra air holes, moderate compaction (100N), and heavy compaction (556.2N).

Materials and methods

Plant conditions

Four plants were maintained under rigorously controlled, invariant conditions throughout the experimental procedure. Specimens were housed in a climate-regulated chamber at 68°F±2 with controlled humidity maintained at 40%±10. Light availability was held at a consistent, optimal level for photosynthetic activity. Uniform pot dimensions and soil volume of 60g was employed across all replicates. Seeds were sourced from a single lot to minimize genetic variation among subjects. Irrigation was administered at every measurement point at precisely 15ml per application. Gardening top soil was utilized for all experimental units.

Testing methodology

Plant height from the soil surface was measured at different intervals using a standard yardstick. Foliar inventory, encompassing both mature and developing leaves, was conducted every other day. This protocol was maintained over a 17-day experimental period. The plants were compacted using a known weight during the planting, and during the first watering. A glass beaker was used to compact the soil. One subject was exposed to no compaction, where it was simply covered with soil. For the simplicity of the experiment, this subject can also be considered the control subject. The second subject was exposed to compaction of approximately 556.2 Newtons. A third subject was exposed to a rational compaction of approximately 100 Newtons. The 4th subject had its soil aerated by poking holes in the soil.

Results

Observation Date	29/10/2025 (2 days in)	3/11/2025 (7 days in)	5/11/2025 (9 days in)	7/11/2025 (11 days in)	13/11/2025 (17 days in)
Control	0mm, 0 leaves	35mm, 4 leaves	30mm, 4 leaves	35mm, 4 leaves	50mm, 10 leaves
Aerated Specimen	0mm, 0 leaves	50mm, 6 leaves	45mm, 6 leaves	50mm, 6 leaves	65mm, 13 leaves
100N Specimen	0mm, 0 leaves	30mm, 6 leaves	45mm, 6 leaves	45mm, 6 leaves	45mm, 12 leaves
556.2N Specimen	0mm, 0 leaves	40mm, 6 leaves	55mm, 6 leaves	55mm, 6 leaves	55mm, 9 leaves

Conclusion

The aerated plant performed the best, reaching 65mm tall with 13 leaves by day 17. This shows that extra air in the soil helps roots grow better and supports more leaf development.
The control plant caught up significantly by the end, growing to 50mm with 10 leaves. The moderately compacted plant (100N) stayed shorter at 45mm but still developed 12 leaves. The heavily compacted plant (556.2N) reached 55mm but only produced 9 leaves, showing that heavy compaction limits leaf growth even if the plant grows tall. The roots paint the same picture with the aerated being extremely long, 100N and Control being about the same in the middle, and the 556.2N specimen having almost no roots.

Discussion

The aerated plant's success makes sense because the extra air holes increased oxygen availability to the roots. Plant roots need oxygen for cellular respiration to get energy for growth and nutrient absorption.

The heavily compacted plant (556.2N) grew tall but produced fewer leaves. The compacted soil probably made it harder for roots to spread horizontally, so the plant compensated by growing upward instead. However, the stress from compaction limited leaf production and photosynthesis.
The moderately compacted plant (100N) had good leaf production despite being shorter. Moderate compaction might provide benefits like better water retention while not blocking root growth completely. The control plant's late growth spurt suggests that watering and root growth gradually loosened the soil over time.
A major difference between root growth was observed. The aerated specimen featured roots approximately 3x its height, the 100N and control specimen feature roots about half its height while the 556.2N specimen only grew about 1/10th of the total height in root. This clearly supports our hypothesis and arguments although remains largely inconclusive with the 100N and control specimen.
One major limitation is that we only used one pot per treatment, so a single measurement error or treatment mistake could significantly affect results. Future experiments should use multiple pots per treatment for more reliable data.

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Ethics Declaration

No subjects were harmed in the making of this study.

Competing Interests

The authors declare that they have no competing interests. This research was funded by Doral Academy Red Rock.