The Effect of Gibberellins on Dwarf Millet Growth

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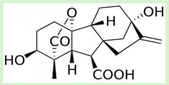


Introduction:

- Millet is a drought-resistant cereal grain widely cultivated in Africa for its nutritional value and ability to thrive in harsh environments.
- Gibberellins is a plant hormone that stimulates plant growth
- Dwarf Millet varieties either don't produce any GA_3, an insufficient amount, or cannot use the GA_3 they produce.

Methods:

- Millet height in millimeters measured and recorded every Friday, beginning Week 1 after germination.
- This data will help determine whether the applied gibberellin promotes elongation in dwarf genotypes and whether the growth response varies between different genotypes.
- The experimental group was treated with a 125 ml solution containing 0.8 g of gibberellins with 25 ml of acetone and 100ml of tap water; applied directly to the meristem.

Experimental Design:

Purpose: Identify the mechanism of dwarfism in the millet genotypes.

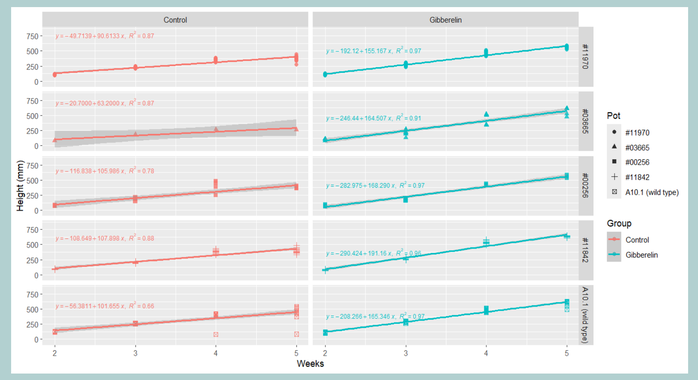
Research Question: What is the underlying cause of genetic dwarfism in different dwarf millet genotypes?

Null Hypothesis (H_0): Gibberellin application has no significant effect on the growth of dwarf millet. Any observed differences in plant height between treated and untreated groups are due to random variation rather than the gibberellin treatment.

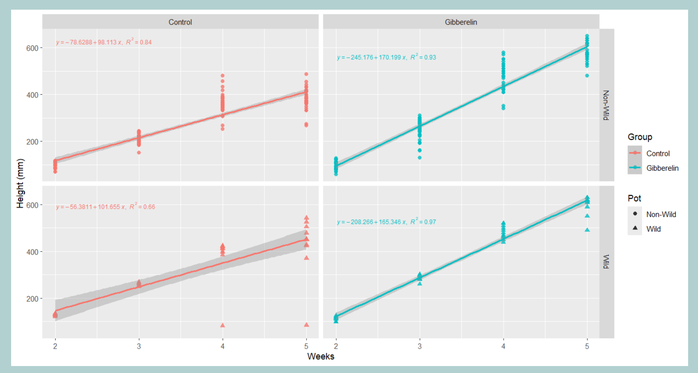
Alternative Hypothesis (Ha): Gibberellin application significantly increases the growth of dwarf millet, indicating that the dwarf genotypes either produce insufficient gibberellins or are unable to utilize them effectively.

This study examines five millet genotypes: four dwarf varieties (11970, 00256, 03665, and 11842) and one wild-type variety (A10.1). Seeds were planted on February 14, 2025, in two sets of 3x5 pots, with each row containing four seeds per genotype. One set received gibberellin treatment, while the others served as a control. The pots were connected to a waterbed that ensured consistent hydration.

Graph A: Individual Data



Graph B: Grouped Data



Results:

Understanding Graph Analysis:

- The R-squared value on each graph tells us whether there is a linear relationship between the data; the closer the value is to 1, the stronger the correlation.
- The slope of the graph will be the number beside the x-variable (weeks) in the equation of the line (regression line).

Interpreting the Graphs:

- Both Graph A and Graph B show that there is a very strong linear correlation between the number of weeks that the dwarf millet genotypes had been planted, and their height.
- There is a clear increase in slope from the control group to the group with gibberellin added. This indicates that the gibberellin has a positive effect on the growth of dwarf millet genotypes.

Conclusion:

- Both wild and non-wild dwarf millet types proved to be gibberellin-responsive. We can say this as all pots had showed a slope increase between the control and the gibberellin-added plants in our graph analysis. The null hypothesis was rejected, and the alternate hypothesis was supported. All dwarf genotypes showed a significant response to the treatment.

Significance

- Millet is a staple crop for millions of people, particularly in Africa, where its drought resistance makes it a vital food source.
- Dwarf Millet has potential to reduce crop yields

Further Research

- Further research, particularly in genetic and molecular analysis, would help determine the path of dwarfism, the affected genes, and the proteins that are impacted for each dwarf genotype.

References:

- Chen JG, Zhou X, Zhang YZ. 1998. Gibberellin-responding and non-responding dwarf mutants in foxtail millet. Plant Growth Regulation. 26: 19-24.
- Fujioka S, Yamane H, Spray CR, Katsumi M, Phinney BO, Gaskin P, MacMillan J, Takahashi N. 1988. The dominant non-gibberellin-responding dwarf mutant (D8) of maize accumulates native gibberellins. Proc Natl Acad Sci USA. 85: 9031–9035.
- Phinney BO. 1956. Growth response of single-gene dwarf mutants in maize to gibberellic acid. Proceedings of the National Academy of Sciences. 42(4): 185-189.
- Plaza-Wüthrich1 S, Blösch1 R, Rindisbacher1 A, Cannarozzi1 G, Tadele1 Z. 2016. Gibberellin deficiency confers both lodging and drought tolerance in small cereals. 13: DOI:10.3389/fpls.2016.00643
- Winkler RG, Freeling M. 1994. Physiological genetics of the dominant gibberellin-nonresponsive maize dwarfs, Dwarf8 and Dwarf9. Springler Nature. 193: 341-348.