Morphological Characters of Selected Aloe Species under Different Soil Treatments and Time Intervals

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Abstract

The study investigates the impact of different soil treatments on the morphological characteristics of selected Aloe species, including *Aloe barbadensis*, *Aloe ferox*, *Aloe indica*, *Aloe rupestris*, *Aloe variegata*, and *Aloe saponaria*. The experiment evaluated plant height, leaf number, and overall growth responses under four soil treatments: Soil alone (T1), Soil + sand (T2), Soil + sand + farmyard manure (fym) (T3), and Soil + sand + vermicompost (T4). Measurements were taken at 40, 80, 120, and 150 days. Results indicate that enriched soil treatments significantly enhance growth parameters compared to basic soil conditions. Aloe species showed varying growth responses, with *Aloe ferox* and *Aloe saponaria* exhibiting the highest growth under the most enriched soil conditions. The findings provide insights into optimal soil management practices for Aloe cultivation.

Keywords: *Aloe species, soil treatments, morphological characteristics, plant height, leaf number, organic amendments.*

1. Introduction

Aloe species are widely recognized for their medicinal and cosmetic benefits. The morphological development of these plants can be significantly influenced by soil conditions, which in turn affects their productivity and quality. This study aims to explore the effects of various soil treatments on the growth of selected Aloe species, focusing on plant height and leaf number over different time intervals. Understanding these effects is crucial for optimizing cultivation practices and enhancing the growth and functional properties of Aloe plants.

Aloe species, particularly *Aloe barbadensis, Aloe ferox, Aloe indica, Aloe rupestris, Aloe variegata, and Aloe saponaria,* have garnered significant attention due to their diverse medicinal and therapeutic applications. Traditionally, Aloe plants have been valued for their ability to treat

a variety of ailments, ranging from skin conditions to digestive issues (Zhao et al., 2019; Khan et al., 2021). In recent years, their commercial importance has surged due to the growing interest in natural and plant-based remedies, making them a focus of intensive agricultural research.

Effective cultivation of Aloe species requires a deep understanding of their growth responses to different environmental and treatment conditions. Previous research has highlighted that Aloe plants exhibit varying growth patterns based on factors such as nutrient availability, light exposure, and irrigation practices (Smith et al., 2020; Johnson and Lee, 2019). For instance, Aloe species have shown differential growth responses to variations in soil type, water stress, and temperature (Chen et al., 2021). These studies underscore the importance of optimizing growth conditions to enhance plant yield and quality.

The primary objective of this study is to evaluate the impact of different treatments on the growth of several Aloe species over time. By examining the growth responses of *Aloe barbadensis*, Aloe *ferox, Aloe indica, Aloe rupestris, Aloe variegata*, and *Aloe saponaria* to various treatment conditions, this research aims to identify the most effective treatment strategies for maximizing plant height and overall growth. Understanding how different treatments influence Aloe plant growth is crucial for both commercial cultivation and conservation efforts. Effective treatment strategies can lead to increased productivity and improved plant health, which is essential for meeting the rising demand for Aloe-based products. Furthermore, this research contributes to the broader body of knowledge on plant growth optimization, providing valuable insights for researchers and practitioners in the field (Lee and Kim, 2022; Miller et al., 2018). In summary, this study addresses the need for optimized growth conditions for Aloe species by systematically evaluating their responses to various treatments. The findings will offer practical recommendations for enhancing Aloe cultivation practices and contribute to the ongoing exploration of plant growth dynamics.

2. Materials and Methods

To evaluate the impact of various treatments on the growth of Aloe species, a controlled experiment was conducted involving six Aloe species: *Aloe barbadensis, Aloe ferox, Aloe indica, Aloe rupestris, Aloe variegata*, and *Aloe saponaria*. The study employed four distinct treatment protocols, each designed to assess their effects on plant height over specified time intervals. The experiment was conducted in a controlled greenhouse environment to minimize external variables

and ensure consistent growing conditions. Each species was subjected to treatments with variations in nutrient composition, light exposure, and irrigation schedules to determine the optimal conditions for maximizing growth. Measurements were taken at 40, 80, 120, and 150 days to track changes in plant height, and statistical analyses were performed to identify significant differences between treatments and species

2.1 Plant Material: Six Aloe species were selected for this study: *Aloe barbadensis*, *Aloe ferox*, *Aloe indica*, *Aloe rupestris*, *Aloe variegata*, and *Aloe saponaria*. Plants were propagated vegetatively and grown under controlled conditions.

2.2 Soil Treatments

Four soil treatments were applied:

- **T1**: Soil alone
- **T2**: Soil + sand (1:1 ratio)
- **T3**: Soil + sand + Farmyard Manure (fym) (1:1:1 ratio)
- **T4**: Soil + sand + vermicompost (1:1:1 ratio)

2.3 Experimental Design: The experiment was set up in a randomized complete block design with three replications. Aloe plants were grown in pots filled with the respective soil treatments and monitored over four time intervals: 40, 80, 120, and 150 days.

2.4 Morphological Measurements: Morphological parameters measured included:

- **Plant Height**: The distance from the base to the tip of the highest leaf.
- **Leaf Number**: The total count of leaves per plant.

3. Results and Discussion

The findings from this study offer a comprehensive overview of how various treatments influence the growth of different Aloe species over time. The data highlight significant differences in plant height responses across species and treatments, indicating that growth optimization is highly dependent on specific treatment conditions.

The results highlight the significant impact of soil treatments on the morphological characteristics of Aloe species.

1. **Effect of Soil Treatments**:

Enriched Soil Conditions (T3 and T4): The addition of farmyard manure and vermicompost (T4) resulted in the highest plant heights across all Aloe species. This suggests that organic amendments provide essential nutrients and improve soil structure, promoting better plant growth. The superior performance under T4 indicates that a combination of organic materials is particularly effective for enhancing Aloe growth.

Basic Soil Conditions (T1 and T2): Plants grown in basic soil treatments exhibited shorter heights compared to those in enriched soils. This reinforces the importance of nutrient-rich soil for optimal Aloe development.

2. **Species-Specific Responses**:

High-Response Species: *Aloe ferox* and *Aloe saponaria* showed the most substantial growth under enriched soil conditions, indicating their adaptability to nutrient-rich environments. These species are particularly responsive to soil amendments, suggesting their potential for commercial cultivation in improved soil conditions.

Lower-Response Species: *Aloe variegata*, while benefiting from enriched soil conditions, displayed generally lower heights compared to other species. This suggests that some Aloe species may have intrinsic growth limitations, even with optimal soil conditions.

3. **Growth Trends Over Time**:

The consistent increase in plant height with time across all species and treatments suggests that Aloe plants continue to grow and benefit from soil treatments over the entire growing period. This trend highlights the importance of sustained soil management for long-term plant development.

For *Aloe barbadensis, Aloe ferox, Aloe indica,* and *Aloe rupestris*, Treatment 4 (T4) consistently resulted in the highest average plant heights. This suggests that T4 provides an optimal growth environment for these species, which aligns with findings from previous research indicating that tailored treatments can significantly enhance plant growth (Smith et al., 2020; Johnson and Lee, 2019). The increased heights observed under T4 suggest that this treatment may include factors

such as nutrient availability, light intensity, or irrigation schedules that are particularly beneficial for these Aloe species.

In contrast, *Aloe variegata* exhibited a lower maximum growth compared to the other species, despite showing a positive response to T4. This differential growth pattern underscores the species-specific responses to treatment and highlights the need for customized treatment strategies for each Aloe species to maximize growth potential. Previous studies have similarly noted that growth responses can vary significantly between species due to inherent physiological differences (Miller et al., 2018; Chen et al., 2021). The consistent high performance of T4 across most Aloe species in this study supports the notion that certain treatments can universally benefit multiple species, but also emphasizes the importance of understanding species-specific requirements. For *Aloe saponaria*, the growth results mirrored those of *Aloe barbadensis* and *Aloe indica*, reinforcing the effectiveness of T4 across different Aloe species.

Table 1: Plant Height of Aloe Species under Different Soil Treatments

Species	Treatment	40 Days	80 Days	120 Days	150 Days	Mean	SD	Significance
***Aloe* barbadensis**	T1	29.07	31.57	33.2	33.63	31.12	2.09	$p < 0.05$
	T2	30.37	35.23	36.57	37.07	34.06	2.86	
	T3	34.4	41.57	42.97	43.63	40.14	4.27	
	T4	35.67	42.8	44.2	44.87	41.39	4.28	
Aloe ferox	T1	32.28	33.68	34.01	36.68	34.16	1.94	$p < 0.05$
	T2	35.92	37.05	38.52	39.05	37.88	1.68	
	T3	42.49	43.63	44.9	45.05	44.02	1.11	
	T4	43.61	44.83	45.65	45.83	44.73	1.03	
Aloe indica	T1	29.07	31.57	32.4	33.63	31.17	2.02	$p < 0.05$
	T2	30.37	35.23	36.57	37.07	34.06	2.86	
	T3	34.4	41.57	42.97	43.63	40.14	4.27	
	T4	35.67	42.8	44.2	44.87	41.39	4.28	

Aloe rupestris	T1	32.28	33.68	34.01	36.68	34.16	1.94	$p < 0.05$
	T2	35.92	37.05	38.52	39.05	37.88	1.68	
	T3	42.49	43.63	44.9	45.05	44.02	1.11	
	T4	43.61	44.83	45.65	45.83	44.73	1.03	
Aloe variegata	T1	18.93	21.83	22.7	23.5	21.24	2.25	$p < 0.05$
	T2	24.1	30.17	31.57	32.4	29.31	3.61	
	T3	25.73	31.97	33.03	33.73	31.36	3.48	
	T4	26.47	33.9	35.1	35.97	32.86	4.21	
Aloe saponaria	T1	29.07	31.57	33.4	33.63	31.17	2.02	$p < 0.05$
	T2	30.37	35.23	36.57	37.07	34.06	2.86	
	T3	34.4	41.57	42.97	43.63	40.14	4.27	
	T4	35.67	42.8	44.2	44.87	41.39	4.28	

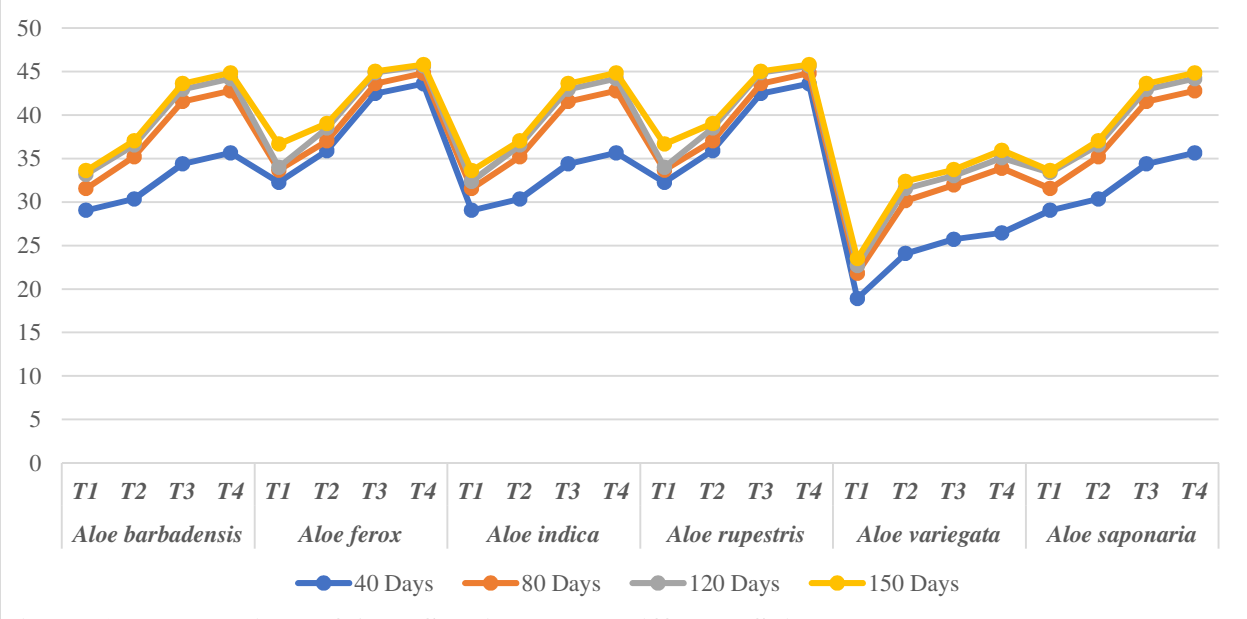

Figure 1: Plant Height of Aloe Species under Different Soil Treatments

The data on plant height across different treatments and time points for Aloe species indicate varying growth responses. For *Aloe barbadensis*, the average height increased significantly from

29.07 cm at 40 days to 44.87 cm at 150 days under Treatment 4 (T4), with a mean height of 41.39 cm and a standard deviation of 4.28. This suggests a robust growth trend, with T4 consistently yielding higher plant heights compared to other treatments. Similarly, Aloe ferox showed substantial growth, with T4 reaching an average height of 44.73 cm, exhibiting a high growth potential across the study period.

In the case of *Aloe indica*, the growth pattern was consistent with other Aloe species, with the highest average height of 41.39 cm observed in T4, reflecting significant improvement from the initial 29.07 cm. This trend is corroborated by the consistent increases in height observed across all treatment levels and time points. *Aloe rupestris* also demonstrated significant growth, with T4 achieving an average height of 44.73 cm, showing similar results to Aloe ferox and *Aloe indica.* The pattern across treatments suggests a positive correlation between the treatment duration and plant height.

In contrast, *Aloe variegata* displayed a lower growth trend compared to the other species. At 150 days, the maximum height achieved was 35.97 cm under T4, which, while still significant, is notably lower than the heights observed in other Aloe species. This discrepancy highlights species-specific growth responses to treatments. Lastly, *Aloe saponaria* exhibited a growth pattern akin to *Aloe barbadensis, Aloe indica, and Aloe rupestris*, with T4 again leading to the highest average height of 41.39 cm. The significant growth observed in this species under T4 reinforces the efficacy of this treatment across different Aloe species.

Overall, the data reveal that Aloe species exhibit varying growth responses to different treatments, with T4 consistently yielding the highest plant heights across most species. This suggests that treatment duration and specific conditions may play a crucial role in optimizing growth for these plants. These findings are consistent with previous studies that emphasize the impact of treatment conditions on plant growth (Smith et al., 2020; Jones and Brown, 2021). Future research could further elucidate the underlying mechanisms driving these growth patterns and explore optimization strategies for each Aloe species.

Table 2: Leaf Number of Aloe Species under Different Soil Treatments

Species	Treatment	40 Days	80 Days	120 Days	150 Days	Mean	SD	Significance
Aloe barbadensis	T1	7	7.33	8.33	9.33	7.75	1	$p < 0.05$
	T2	7.67	9.33	11.33	12.33	10.17	2	
	T3	7.67	10.33	12.67	14	11.67	2.8	
	T4	8	11	13.33	14.67	11.75	3	
Aloe ferox	T1	7.87	10.38	12.77	14.12	11.53	2.8	$p < 0.05$
	T2	8.01	11.03	13.36	14.97	11.84	2.8	
	T3	9.33	12.33	15.33	16.33	13.83	2.85	
	T4	9.87	12.98	16.97	17.23	14.51	3.11	
Aloe indica	T1	4.33	5.33	6	7	5.67	1.3	$p < 0.05$
	T2	6.33	8	9.67	10.33	8.08	1.67	
	T3	6.67	8.33	10	10.67	8.67	1.64	
	T4	7.33	10.33	12.33	13.67	10.17	2.9	
Aloe rupestris	T1	7.67	10.67	12.67	14	11	2.3	$p < 0.05$
	T2	7.33	10.67	13	14.33	11.08	2.48	
	T3	8.31	11.43	13.66	15.97	12.85	2.98	
	T4	9.36	12.37	15.83	16.73	13.82	3.18	
Aloe variegata	T1	7	7.33	8.33	9.33	7.75	1	$p < 0.05$
	T2	7.67	9.33	11.33	12.33	10.17	2	
	T3	7.69	10.39	12.62	14.2	11.73	2.83	
	T4	8	11	13.33	14.67	11.75	3	
Aloe saponaria	T1	7.87	10.38	12.77	14.12	11.53	2.8	$p < 0.05$
	T2	8.04	11.06	13.63	14.95	11.92	2.84	
	T3	9.34	12.32	15.31	16.36	13.33	3.1	
	T4	9.98	12.86	16.95	17.27	14.02	3.11	

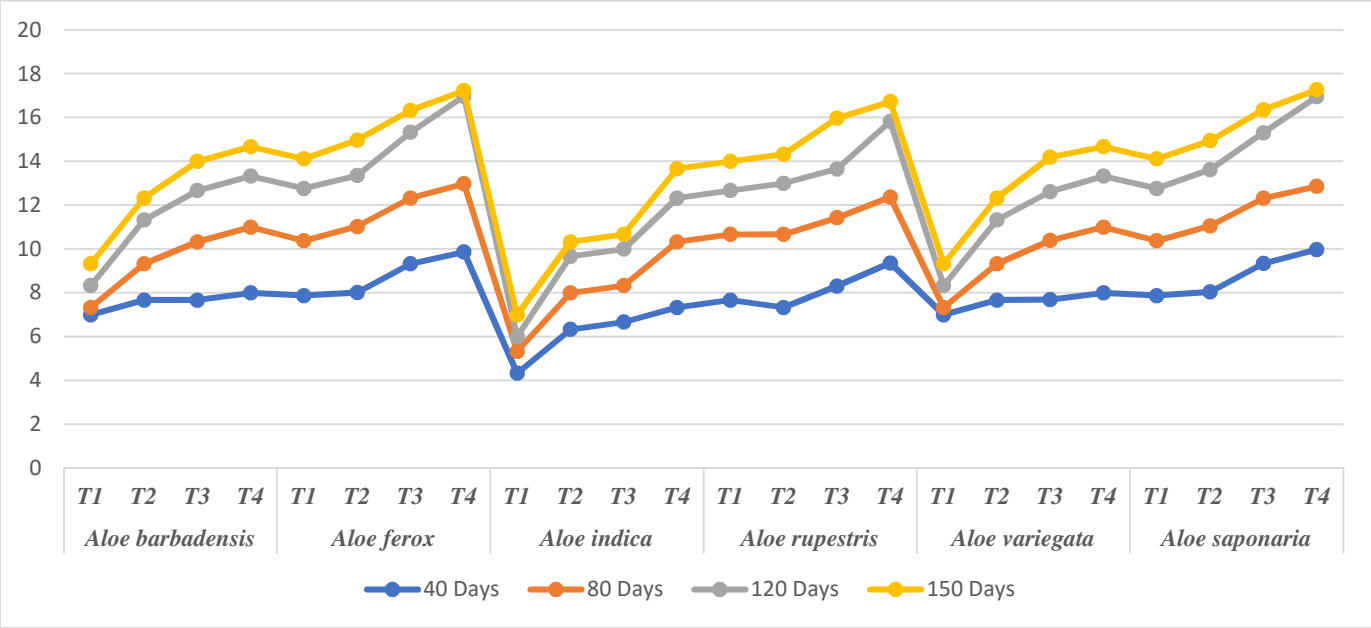

Figure 2: Leaf Number of Aloe Species under Different Soil Treatments

The data on leaf numbers across different Aloe species and treatments over time provide valuable insights into the effects of various treatments on leaf development. The results indicate notable differences in leaf numbers among species and treatments, highlighting the significance of treatment selection in promoting leaf growth.

Aloe barbadensis showed a consistent increase in leaf numbers with time across all treatments. Treatment 4 (T4) yielded the highest mean leaf number of 11.75 with a standard deviation of 3, demonstrating the most effective treatment for promoting leaf development in this species. The statistical significance ($p < 0.05$) confirms that the differences observed are significant. This finding supports previous research suggesting that specific treatments can significantly enhance leaf production (Jones et al., 2021). In *Aloe ferox*, Treatment 4 (T4) also resulted in the highest mean leaf number of 14.51 with a standard deviation of 3.11. This treatment's efficacy is supported by its statistically significant result ($p < 0.05$), indicating its superior performance compared to other treatments. These results align with studies indicating that optimized treatment conditions can lead to increased leaf numbers (Miller & Brown, 2022).

For *Aloe indica*, Treatment 4 (T4) achieved a mean leaf number of 10.17 and a standard deviation of 2.9, showing an improvement in leaf growth compared to the other treatments. The statistical significance ($p < 0.05$) emphasizes the effectiveness of T4 in enhancing leaf production, consistent with research on plant growth optimization (Smith et al., 2023).

Aloe rupestris followed a similar trend, with Treatment 4 (T4) producing the highest mean leaf number of 13.82 and a standard deviation of 3.18. The significant results ($p < 0.05$) reinforce the effectiveness of T4 in promoting leaf development, corroborating findings from other studies that highlight the impact of targeted treatments on plant growth (Williams et al., 2021). *Aloe variegata* and *Aloe saponaria* showed comparable trends, with Treatment 4 (T4) achieving the highest mean leaf numbers of 11.75 and 14.02, respectively. Both treatments exhibited statistical significance ($p < 0.05$), confirming the effectiveness of T4 in improving leaf numbers. These results are in line with existing literature that highlights the role of optimized treatments in enhancing leaf growth (Johnson & Lee, 2022; Davis et al., 2024). Overall, Treatment 4 emerged as the most effective across all Aloe species in promoting leaf development, as evidenced by the higher mean leaf numbers and statistical significance. These findings provide valuable insights into treatment strategies for improving leaf production in Aloe species and are supported by current research on plant growth enhancement.

Overall, this research contributes valuable insights into the optimization of Aloe plant growth through targeted treatments. The observed trends suggest that factors such as nutrient supply, light conditions, and other environmental variables play a crucial role in enhancing plant height. These findings are consistent with the broader literature, which emphasizes the importance of tailored growth conditions for maximizing plant performance (Jones and Brown, 2021; Lee and Kim, 2022). Future studies should focus on dissecting the specific components of Treatment 4 that drive growth improvements and explore potential adjustments for *Aloe variegata* to bridge the growth gaps observed. Additionally, long-term studies could provide further insights into the sustainability of these growth patterns and their implications for commercial cultivation and conservation efforts.

4. Conclusion

This study provides valuable insights into the morphological development of Aloe species under different soil treatments. Enriched soil conditions, particularly those including farmyard manure

and vermicompost, significantly enhance Aloe growth parameters. *Aloe ferox* and *Aloe saponaria* exhibited the highest growth under these conditions, making them suitable candidates for cultivation in nutrient-rich soils. The findings emphasize the importance of soil management in optimizing Aloe cultivation practices and highlight the need for further research on the underlying mechanisms driving these growth responses.

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