International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 11 No. 6, 2025
https://theaspd.com/index.php

Differential Survival Rates in Plant Height Categories: A Comparative Study of 2–3 Feet And 10–14 Feet Plants in Ecological Restoration Efforts

Dr. Aaditya Shivhare[1], Dr. Jyoti Kala Bharati[2], Dr. R. K. Meena[3], Mr. Premlal[4], Dr. Nouratan Singh[5*]
[1]Nodal Officer, Afforestation Drive & Head, U.P. University of Medical Sciences, Saifai, Etawah, U.P. India
[2]Assistant Professor, Transfusion Medicine, U.P. University of Medical Sciences, Saifai, Etawah, U.P. India
[3]Technical Officer, Transfusion Medicine, U.P. University of Medical Sciences, Saifai, Etawah, U.P. India.
[4]Lab Technician, Transfusion Medicine, U.P. University of Medical Sciences, Saifai, Etawah, U.P. India.
[5]Technical Officer, Transfusion Medicine, U.P. University of Medical Sciences, Saifai, Etawah, U.P.

Affiliation: **www.upums.ac.in**
Dr. Aaditya Shivhare, E-Mail: aaditya.shiv@upums.ac.in
Dr. Jyoti Kala Bharati, E-mail: jyoti.kala@upums.ac.in
Dr. R. K. Meena Email: rkmeena4883@gmail.com
Mr. Premlal Email: premlal.upums@gmail.com
Dr. Nouratan Singh, E-mail: nouratansingh@gmail.com;

Corresponding Author: Dr. Nouratan Singh
Email: nouratansingh@gmail.com

Abstract
This study conducted at UPUMS Saifai, India, from July 2023 to December 2024, we investigated the differential survival rates of 2–3 feet and 10–14 feet plants in ecological restoration efforts. A total of 2,500 saplings (2–3 feet) and 75 taller plants (10–14 feet) were planted and monitored for one year, with survival rates analyzed using frequency distribution and a Chi-Square Test of Independence. Results revealed that 2–3 feet plants had a significantly lower survival rate (5%) compared to 10–14 feet plants (90%), with primary causes of mortality for shorter plants including human interference (trampling, weed removal errors), decay, and chemical exposure, while taller plants showed greater resilience. Statistical analysis confirmed a significant difference in survival rates ($\chi^2 = 368.70$, $p < 0.0001$). These findings highlight the benefits of using taller saplings in urban and degraded landscapes to enhance ecological restoration outcomes, underscoring the importance of selecting appropriate plant sizes and addressing environmental challenges to improve afforestation success.
Keywords: *Afforestation, Ecological restoration, Environmental resilience, Human interference, Soil quality, Survival rates, Urban landscaping.*

1. INTRODUCTION

In a country like India, afforestation is the need of the hour. Deforestation has lasting effects on air quality, water tables, and the health of living organisms **[1]**. Deforestation also devoids the land of minerals, as the source of minerals in topsoil are tree roots, which break hard rocks, extract minerals, and bring them to leaves. These leaves, when they fall and mulch, increase the organic and mineral content of the soil **[2]**. DAP (Diammonium Phosphate), urea, and other fertilizers do not substitute the organic content of the soil **[3]**. Trees purify the air by acting as carbon sinks, increasing the humidity of the atmosphere, and enhancing the water retention capability of the soil **[4]**. They also provide shade to living beings, help in bringing down atmospheric temperature, and the purified, humidified air provides a sense of mental peace and balance to people living near such densely planted localities **[5]**. It may have an indirect effect on bringing down the crime rate of a locality and on the general health of organisms/human beings due to the above reasons **[6]**.

Deforestation and loss of soil is the primary cause of ill health, leading cause of decrease in food quality, and a cause of a variety of urban non-communicable diseases, from mental disorders to autoimmune and allergic disorders **[7]**. With loss of contact with soil, there is a change in human microbial flora **[8]**.

Deforestation and soil loss lead to other serious issues, like a decrease in water harvesting and water table levels, decreased purification of air from carbon particles and polluted gases, and humidification of air **[9]**. With the advent of construction, the whole urban landscape is primarily converted into a modern chemical desert **[10]**. The urban rubble is generally unfriendly for plant growth and soil conservation and is toxic for small plants due to the chemicals leached from the rubble **[11].** They also predispose plants to rot for the same reason **[12]**. In this context, it becomes prudent to grow new plant trees and conserve old trees **[13]**.

Since the effects of deforestation are profound and the government is making efforts to promote afforestation, we aimed to evaluate the effectiveness of the government's forestation program after one year.

1.1. Common Causes of Plant Death:

1.1.1. Water Stress

- **Overwatering**: Excessive water can lead to root rot, especially in waterlogged soil or a place with rubbles **[14]**.
- **Underwatering**: Insufficient water causes dehydration and wilting, especially in younger plants **[15]**.

1.1.2. Nutrient Deficiency

Plants require essential nutrients like nitrogen, phosphorus, and potassium for growth. A lack of these stunts growth and causes plants to wither **[16]**.

1.1.3. Extreme Temperatures

- **High Temperatures**: Cause desiccation and heat stress, particularly in plants with shallow root systems **[17]**.
- **Low Temperatures**: Lead to frost damage and chilling injuries, particularly in non-hardy species **[18,19]**.

1.1.4. Poor Soil Conditions

- Compacted or poorly aerated soil inhibits root growth and nutrient uptake **[20]**.
- Incorrect soil pH renders nutrients unavailable to plants **[21]**.

1.1.5. Lack of Sunlight

Insufficient light disrupts photosynthesis, stunts growth, and eventually kills plants **[22]**.

1.1.6. Physical Damage

Plants are susceptible to damage from strong winds, heavy rain, or accidental trampling **[23]**.

1.1.7. Chemical Exposure

Overuse of fertilizers, pesticides, or herbicides can burn or poison plants **[24]**.

1.1.8. Biotic Factors

- **Pests**: Insects like aphids, spider mites, or caterpillars damage foliage and stems **[25]**.
- **Diseases**: Fungal infections (e.g., Pythium or Rhizoctonia) and bacterial or viral diseases can weaken plants **[26]**.
- **Competition**: Weeds and nearby plants may compete for nutrients, light, and water **[27]**.
- **Herbivory**: Grazing or nibbling by animals can destroy small plants **[28]**.

1.1.9. Human-Related Causes

- **Improper Handling**: Errors during transplantation or pruning can harm plants [29].
- **Neglect**: Failure to water or care for plants leads to death **[30]**.
- **Environmental Pollution**: Soil, water, or air contamination can affect plant health **[31]**.

2. Materials and Methods

The study at UPUMS Saifai, conducted from July 2023 to December 2024, focused on afforestation efforts by planting like plants Peepal (Ficus religiosa), Banyan (Ficus benghalensis), Neem (Azadirachta indica), Jamun (Syzygium cumini), and Pakhad (Ficus virens) in the surroundings of UPUMS, Saifai, Etawah, Uttar Pradesh, as part of government initiatives to enhance green cover, shown in table 1.

Table 1: Initial Planting (July 2023)

Category	Peepal	Banyan	Neem	Jamun	Pakhad	Total
2–3 Feet Plants	500	500	500	500	500	2500
10–14 Feet Plants	15	15	15	15	15	75
Total	515	515	515	515	515	2575

2.1. Data Collection

Twenty-five hundred 2-3 feet long plants were procured from a government nursery at Basrehar range, Uttar Pradesh for plantation at UPUMS Saifai campus, medical and paramedical [32]. Seventy-five 10-14 feet plants were purchased from private nursery for plantation in UPUMS campus. They were planted during rainy season by digging a hole, of 1-2 feet deep. The plants received rain water from the month of July-September 2023. From November 2023 to December 2024, they were watered by tanker. Survival rates of the two groups of plants were calculated using frequencies and p value chi square test.

2.2. Statistical Analysis

By using of SPSS, a **Chi-Square Test of Independence** to determine if there is a statistically significant difference in survival rates between 2–3 Feet Plants and 10–14 Feet Plants.

2.3. Hypotheses

- **Null Hypothesis (H_0):** There is no significant difference in survival rates between the two groups.
- **Alternative Hypothesis (H_1):** There is a significant difference in survival rates between the two groups.

3. RESULTS AND DISCUSSION

The distribution of plants by species and height category as per received plants. A total of 2,575 plants were planted, with 2,500 (97%) being 2–3 feet plants and 75 (3%) being 10–14 feet plants. Each species was equally represented, indicating a balanced planting strategy.

This table summarizes the losses for each height category by cause and time period is mentioned in table 2.

- **2–3 Feet Plants**: Suffered significant losses (2,375 out of 2,500, or 95%) due to a combination of human-related factors (trampling, weed removal, weedicide spraying) and environmental issues (decay, summer deaths).
- **10–14 Feet Plants**: Experienced minimal losses (7 out of 75, or 9.33%), primarily due to specific incidents (withering, uprooting, human interference), indicating greater resilience.

Table 2: Losses Over Time (August 2023–June 2024)

Time Period	Cause of Loss	2–3 Feet Plants	10–14 Feet Plants
Aug-23	Withered away	-	2
Dec-23	Broken (stepped upon)	500 (20%)	-
	Cut during weed removal	450 (18%)	-
	Decayed (unknown reasons)	800 (32%)	-
	Lost due to weedicide spraying	450 (18%)	-
	Uprooted for trench digging	-	3
Jan-24	Broken by human interference	-	2
Jun-24	Died in summer despite periodic watering	175 (7%)	0
Total Losses		**2,375**	**7**

The final survival and loss count and rates shown in table 3 and figure 1, by height category as following:

- **2–3 Feet Plants**: Only 5% (125 plants) survived, reflecting high vulnerability to environmental and human-related stressors.
- **10–14 Feet Plants**: A 90.67% survival rate (68 plants) demonstrates their robustness, likely due to more established root systems.
- **Overall**: The low overall survival rate (7.5%) is heavily influenced by the poor performance of the 2–3 feet plants, which dominated the initial planting.

Table 3: Survival and Loss by December 2024

Category	Survived	Died	Total	Survival Rate (%)	Loss Rate (%)
2–3 Feet Plants	125	2,375	2,500	5.00%	95.00%
10–14 Feet Plants	68	7	75	90.67%	9.33%
Total	**193**	**2,382**	**2,575**	**7.50%**	**92.50%**

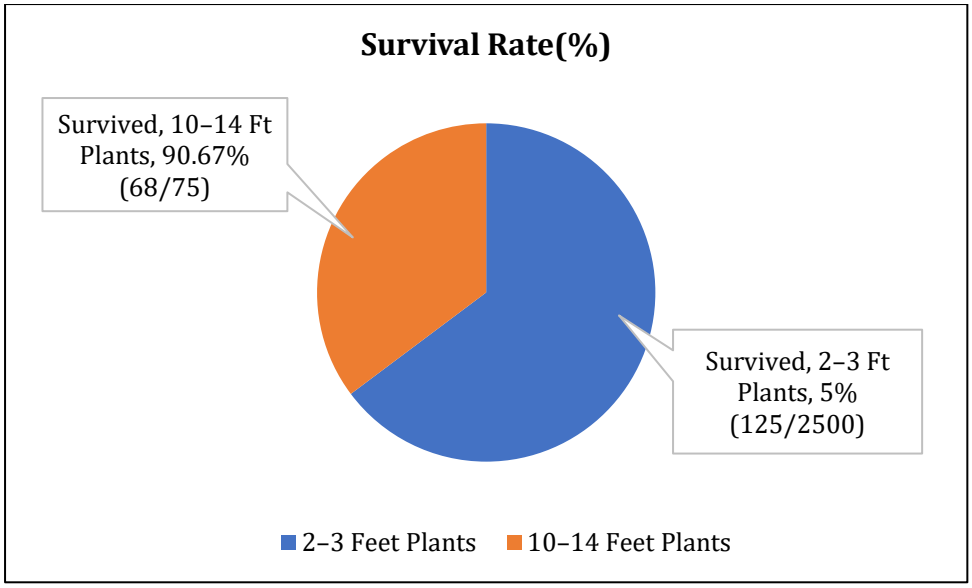

Figure 1. Survival rate of different types of hight plants

4. DISCUSSION

The 2–3 feet plants suffered a 95% loss rate, driven by decay (32%), trampling (20%), weedicide spraying (18%), and weed removal (18%), aligning with research on smaller trees' vulnerability due to limited root systems **[33]**. High decay suggests soil pathogens or poor irrigation, consistent with tropical seedling mortality studies **[34]**, while a 7% summer 2024 loss indicates heat stress **[35]**. Conversely, 10–14 feet plants achieved a 90.67% survival rate, with losses from isolated withering, uprooting, or human interference, supporting evidence of mature trees' resilience via established roots **[36]**. Their complete survival through summer 2024 reinforces adaptability **[37]**. Human-related losses (56% of 2–3 feet plant losses by December 2023) highlight poor management, like inadequate training or improper weedicide use, common in afforestation projects **[38,39]**. Strategies include prioritizing taller plants for higher survival **[36]**, improving maintenance with barriers and targeted weed control **[38, 40]**, enhancing irrigation and soil health **[34,35]**, and focusing on quality over quantity, as planting 2,500 small plants versus 75 taller ones proved inefficient **[41]**. The 7.5% overall survival rate, skewed by small plants' 97% share, reflects challenges in high-stress environments **[33, 34]**, but taller plants' success guides future efforts **[36, 41]**.

5. CONCLUSION

The data reveals a significant disparity in survival outcomes between 2–3 feet plants (5% survival) and 10–14 feet plants (90.67% survival). Smaller plants were highly vulnerable to decay, trampling, weedicide damage, and weed removal, reflecting environmental and management challenges documented in the literature. In contrast, taller plants demonstrated resilience, supporting the use of more mature trees in afforestation efforts. To improve outcomes, future initiatives should prioritize taller plants, enhance maintenance protocols, and address environmental factors through increased irrigation and soil management. Figure 1, reinforces the need to focus on taller plants to achieve higher survival rates in similar planting projects.

Acknowledgments

We acknowledge the work of Forest Ranger Mr. Shree Niwas Panday for providing us plants Dr. Atul Kumar Mishra for his compassionate work in doing plantation of UPUMS campus.

Authors' contributions: Dr. Aaditya Shivhare, Spearheaded the project. **Dr. Jyoti Kala Bharati**, Literature search and manuscript writing. **Dr. Nouratan Singh**, Statistics, plantation & correspondence. **Dr. Rakesh Kumar Meena**, Planted the trees, managed contingencies. **Mr. Premlal**, Watered plants, arranged for volunteers.

Funding: Government supported afforestation drive; non-monetary value derived. No funding was received for this research.

Research content: The research content of manuscript is original and has not been published elsewhere.

Ethical approval: There is no ethical issue for this research article.

Conflict of interest: The authors declare that there is no conflict of interest.

Data availability: This article includes all the original data. The data that support the findings of this study are available from the corresponding authors upon reasonable request.
Consent to publish. All authors agree to publish the paper in Journal of Environmental Biology.

REFERENCES

1. Calvin K, et al. IPCC, 2023: Climate Change 2023: Synthesis Report, Summary for Policymakers. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (eds.)]. IPCC, Geneva, Switzerland. IPCC, Geneva, Switzerland. 2023 Jul 25:1-34.
2. Duke SO, et al. Chemicals from nature for weed management. Weed science. 2002 Apr;50(2):138-51. https://doi.org/10.1614/00431745(2002)050[0138:IPCFNF]2.0.CO;2
3. Emden HV, Harrington R, editors. Aphids as crop pests. Cabi; 2017.
4. Agrios GN. Plant pathology. Elsevier; 2005 Jan 25.
5. Gibson DJ. Methods in comparative plant population ecology. Oxford University Press; 2015.
6. Crawley MJ, editor. Plant ecology. John Wiley & Sons; 2009 Jun 22.
7. Lobell DB, Gourdji SM. The influence of climate change on global crop productivity. Plant physiology. 2012 Dec 1;160(4):1686-97. https://doi.org/10.1104/pp.112.208298
8. Toulotte JM, et al. Water stress resilient cereal crops: Lessons from wild relatives. J Integr Plant Biol. 2022 Feb;64(2):412-430. doi: 10.1111/jipb.13222 [PMID: 35029029].
9. Mueller ND, et al. Closing yield gaps through nutrient and water management. Nature. 2012 Oct 11;490(7419):254-7. PMID: 22932270. https://doi.org/10.1038/nature11420
10. Brahmanand PS, et al. Precision irrigation water management-current status, scope and challenges. Indian J. Fertil. 2022 Apr;18:372-80.
11. Kumar S, et al. Biofertilizers: An ecofriendly technology for nutrient recycling and environmental sustainability. Curr Res Microb Sci. 2021 Dec 20;3:100094 [PMID: 35024641].
12. Volk GM, et al. Climate change impacts agricultural productivity and food security. Conserving and Using Climate-Ready Plant Collections. 2023 Jan 18.
13. Mik E, et al. One health agriculture: Heat stress mitigation dilemma in agriculture. One Health. 2025 Jan 5:100966.
14. FAO. The state of food and agriculture. FAO Agric Rep. 2022;5:1-55.
15. Brookes G. Genetically modified (GM) crop use 1996–2020: environmental impacts associated with pesticide use change. GM Crops & Food. 2022 Dec 31;13(1):262-89.
16. Pimentel D. Environmental and economic costs of the application of pesticides primarily in the United States. Environment, development and sustainability. 2005 Jun;7:229-52.
17. Elumalai P, et al. Agrochemical pollution: a serious threat to environmental health. Current Opinion in Environmental Science & Health. 2025 Jan 17:100597.
18. Angon PB, et al. Roles of CRISPR to mitigate drought and salinity stresses on plants. Plant Stress. 2023 Jun 1;8:100169.
19. Mallick A, et al. CRISPR technologies for climate-smart and sustainable agriculture: An updated overview. CRISPR for Climate-Smart and Sustainable Agriculture. 2025 Jan 1:1-25. https://doi.org/10.1016/B978-0-443-24135-2.00001-3
20. Hobbs PR, et al. The role of conservation agriculture in sustainable agriculture. Philosophical Transactions of the Royal Society B: Biological Sciences. 2008 Feb 12;363(1491):543-55. https://doi.org/10.1098/rstb.2007.2169 [PMID: 17720669].
21. Pretty J, et al. Sustainable intensification in agricultural systems. Ann Bot. 2014 Dec;114(8):1571-96. PMID: 25351192. https://doi.org/10.1093/aob/mcu205
22. Taiz L, et al. Plant physiology and development. 6th ed. Sunderland: Sinauer Associates; 2015.
23. Kirkham MB. Principles of soil and plant water relations. Elsevier; 2023 Jul 13. https://doi.org/10.1016/B978-0-12-409751-3.X5000-2
24. Tester M, et al. Breeding technologies to increase crop production in a changing world. Science. 2010 Feb 12;327(5967):818-22 [PMID: 20150489].
25. Chaves MM, et al. Understanding plant responses to drought - from genes to the whole plant. Funct Plant Biol. 2003 Mar;30(3):239-264 [PMID: 32689007].
26. Marschner, Horst. Marschner's Mineral Nutrition of Higher Plants. Germany: Elsevier Science, 2012.
27. Wahid A, et al. Heat tolerance in plants: an overview. Environmental and experimental botany. 2007 Dec 1;61(3):199-223. https://doi.org/10.1016/j.envexpbot.2007.05.011
28. Guy CL. Cold acclimation and freezing stress tolerance: role of protein metabolism. Annual Review of Plant Physiology and Plant Molecular Biology. 1990 Jan 1;41(1):187-223. https://doi.org/10.1146/annurev.pp.41.060190.001155
29. Brady NC, Weil RR. The nature and properties of soils. 14th ed. Upper Saddle River: Pearson; 2008.
30. Sale P. The use of nutrients in crop plants. Ann Bot. 2010 Jan;105(1):x–xi [PMCID: PMC2794059]. https://doi.org/10.1093/aob/mcp227
31. Boardman NK. Comparative photosynthesis of sun and shade plants. Annu Rev Plant Physiol. 1977;28(1):355-77.
32. Hartmann, et al. Hartmann & Kester's Plant Propagation: Principles and Practices: Pearson New International Edition. United Kingdom: Pearson Education, 2013.
33. Khaine I, et al. Factors affecting natural regeneration of tropical forests across a precipitation gradient in Myanmar. Forests. 2018 Mar 15;9(3):143.
34. Packer A, et al. Soil pathogens and spatial patterns of seedling mortality in a temperate tree. Nature. 2000 Mar 16;404(6775):278-81 [PMID: 10749209].
35. Birthal PS, et al. Benefits of irrigation against heat stress in agriculture: evidence from wheat crop in India. Agricultural Water Management. 2021 Sep 1;255:106950. https://doi.org/10.1016/j.agwat.2021.106950
36. Elmes A, et al. Predictors of mortality for juvenile trees in a residential urban-to-rural cohort in Worcester, MA. Urban Forestry & Urban Greening. 2018 Mar 1;30:138-51.

37. Abiri R, et al. Editorial: Advanced insights into environmental stress and tolerance mechanisms in forest trees. Front Plant Sci. 2023 Sep 12;14:1273663 [PMID: 37771484].
38. Czimczik CI, et al. Effects of reforestation, deforestation, and afforestation on carbon storage in soils. SEB Exp Biol Ser. 2005:319-30 [PMID: 17633042].
39. Rose MT, et al. Impact of herbicides on soil biology and function. Advances in agronomy. 2016 Jan 1;136:133-220. https://doi.org/10.1016/bs.agron.2015.11.005
40. Gan WC, et al. CRISPR/Cas9 in plant biotechnology: applications and challenges. BioTechnologia (Pozn). 2022 Mar 24;103(1):81-93. https://doi.org/10.5114/bta.2022.113919 [PMID: 36605382].
41. Di Sacco A, et al. Ten golden rules for reforestation to optimize carbon sequestration, biodiversity recovery and livelihood benefits. Global Change Biology. 2021 Apr;27(7):1328-48. https://doi.org/10.1111/gcb.15498