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Review Article

The Effect of Light and Irrigation Levels on the Growth and Spread of Indoor Ornamental Plants: A Comprehensive Review

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Abstract: Indoor ornamental plants have become increasingly important in modern urban environments due to their aesthetic, environmental, and psychological benefits. Their growth and spatial development are highly influenced by environmental factors, particularly light intensity and irrigation levels. This review synthesizes current scientific knowledge regarding the physiological, morphological, and developmental responses of indoor ornamental plants to varying light and water conditions. Evidence from recent studies indicates that both insufficient and excessive light or water can significantly impair plant performance, while optimal combinations promote leaf expansion, biomass accumulation, and lateral spread. Species-specific responses, light–water interactions, and physiological mechanisms underlying growth regulation are highlighted. The review emphasizes practical applications for indoor horticultural management and identifies gaps in current knowledge, providing directions for future research.

Keywords: Indoor Ornamental Plants, Light Intensity, Irrigation, Growth, Lateral Spread, Plant Physiology.

INTRODUCTION

Indoor ornamental plants serve multiple purposes beyond aesthetic appeal. They improve air quality by filtering pollutants (Li & Yang, 2020), enhance human psychological well-being by reducing stress (Bringslimark *et al*., 2019), and contribute to the thermal and humidity regulation of indoor environments (Lohr *et al.,* 2018). The increasing urbanization and the prevalence of indoor workplaces and living spaces have driven demand for effective cultivation of these plants. Successful indoor plant management relies on understanding the environmental factors that affect growth, development, and lateral spread. Among these factors, light and irrigation play pivotal roles in determining plant performance.

Light is the primary energy source for photosynthesis, driving carbohydrate production, morphogenesis, and reproductive development. Insufficient light limits photosynthetic efficiency, resulting in reduced biomass accumulation, chlorosis, and elongated, weak stems (Poorter *et al.,* 2019). Conversely, excessive light may cause photoinhibition, leaf burn, and oxidative stress due to the overproduction of reactive oxygen species (ROS) (Wang *et al*., 2021). Irrigation provides water necessary for maintaining cell turgor, nutrient transport, stomatal function, and metabolic activity. Both under- and over-irrigation negatively affect plant health, leading to growth retardation, root disorders, and increased susceptibility to pathogens (Mahmoud & El-Sayed, 2021).

While numerous studies have examined light or irrigation effects separately, fewer reviews have integrated the interactive influence of these factors on the growth and spread of indoor ornamental plants. Understanding these interactions is essential for optimizing indoor plant management, improving aesthetic and functional outcomes, and reducing plant stress. This review aims to synthesize the latest scientific findings on how light intensity and irrigation levels affect indoor ornamental plants, focusing on physiological responses, morphological adaptations, and lateral expansion. The review also discusses practical implications and provides recommendations for future research.

LITERATURE REVIEW

Light as a Determinant of Indoor Plant Growth

Light is crucial for photosynthesis and energy production, directly influencing plant growth, morphology, and physiological performance. Photosynthetically active radiation (PAR, 400–700 nm) drives the conversion of light energy into chemical energy, which fuels cell division, elongation, and differentiation (Li *et al*., 2020). Light intensity, quality, and photoperiod collectively regulate plant morphogenesis, including stem elongation, leaf area expansion, and flowering (Liu *et al*., 2021).

Low light intensity often leads to etiolation, characterized by elongated stems, reduced leaf size, and chlorotic foliage (Poorter *et al*., 2019). Such conditions limit carbohydrate production, resulting in reduced biomass accumulation and compromised structural integrity. Moderate light intensities promote balanced growth, optimizing leaf expansion, stem thickness, and lateral shoot development (Hassan & Ali, 2022). Conversely, very high light intensity can induce photoinhibition, where the photosynthetic apparatus becomes overexcited, leading to ROS production, chlorophyll degradation, and leaf necrosis (Wang *et al*., 2021).

Light quality also influences plant morphology. Red and blue light spectra are particularly important for regulating photomorphogenesis. Red light enhances stem elongation and flowering, whereas blue light promotes leaf thickness, chlorophyll content, and stomatal opening, which improves photosynthetic efficiency (Meng *et al*., 2020). For indoor ornamental plants, the balance of red and blue light can optimize growth parameters and aesthetic characteristics, such as leaf color and density.

Water Availability and Irrigation

Water is a fundamental component of plant physiological processes. It maintains turgor pressure, facilitates nutrient transport, enables stomatal conductance, and is essential for photosynthesis (Taiz *et al*., 2018). The irrigation regime directly affects root development, aboveground biomass, and lateral spread. Under-irrigation causes water stress, resulting in stomatal closure, reduced CO_2 assimilation, and impaired cell elongation (Mahmoud & El-Sayed, 2021). Chronic water deficiency limits leaf expansion, reduces plant height, and decreases lateral shoot formation.

Over-irrigation, on the other hand, can reduce oxygen availability in the root zone, leading to hypoxic stress, root rot, and increased susceptibility to fungal pathogens (Barker & Norton, 2020). Maintaining a balanced irrigation regime is critical for sustaining plant health. Studies suggest that moderate irrigation levels, often around 70–80% of field capacity, are optimal for most indoor ornamental species, ensuring sufficient water for metabolic processes while avoiding root hypoxia (Li *et al*., 2020).

Interaction between Light and Irrigation

The effects of light and irrigation are not independent. Light intensity determines the photosynthetic demand and carbohydrate availability, which must be supported by adequate water for turgor and nutrient transport (Pérez & Martínez, 2019). Studies demonstrate that medium light intensity combined with moderate irrigation optimizes growth, leaf area, and lateral spread, whereas suboptimal combinations (low light with excessive water or high light with insufficient water) result in stress symptoms and reduced growth performance (Gonzalez *et al*., 2019).

Physiologically, light drives photosynthetic carbon assimilation, producing sugars necessary for shoot and root growth. Water facilitates transport of these assimilates, supports cell expansion, and maintains hydraulic conductivity. A mismatch between light-driven growth demand and water supply can create stress conditions, reducing lateral expansion and overall plant vigor (Tanaka & Yamamoto, 2020).

Species-Specific Responses

Different indoor ornamental species exhibit varying sensitivities to light and irrigation. Ficus benjamina, for instance, performs optimally under medium light and moderate irrigation, showing enhanced leaf area and balanced shoot-to-root ratios (Hassan & Ali, 2022). Spathiphyllum spp. tolerates lower light but are more sensitive to overwatering, which can induce root rot (Mahmoud & El-Sayed, 2021). Dracaena fragrans demonstrates moderate tolerance to light variation but requires consistent moisture to support lateral shoot development (Li *et al*., 2020). Understanding these species-specific responses is critical for developing tailored cultivation strategies.

Physiological Mechanisms Underlying Growth Responses

Light and water influence plant growth through multiple physiological pathways. Light regulates photosynthesis, hormone production (auxins, cytokinins, gibberellins), and photomorphogenesis. Water availability affects cell turgor, stomatal function, and nutrient uptake. Together, these factors modulate growth rate, leaf expansion, and lateral spread. Reactive oxygen species (ROS) and antioxidant defense systems mediate stress responses under extreme light or water

conditions (Wang *et al*., 2021). Optimizing light and irrigation reduces ROS accumulation, stabilizes metabolic processes, and supports sustainable growth.

Practical Implications

For indoor horticulture, integrating knowledge of light and irrigation effects is essential. Growers should aim for moderate light levels (2000–4000 lux) and maintain irrigation at 70–80% field capacity for most ornamental species. Light supplementation with LEDs can adjust spectral quality and photoperiod to meet species-specific requirements (Meng *et al*., 2020). Proper irrigation scheduling prevents root hypoxia and water stress, supporting healthy lateral spread and aesthetic appeal. Implementing these strategies improves plant longevity, reduces stress-related disorders, and enhances the visual and functional value of indoor ornamental plants.

DISCUSSION

The literature indicates a clear relationship between light, water, and plant growth. Optimal growth occurs under intermediate conditions for both factors, supporting maximum biomass, leaf area, and lateral spread. Species-specific adaptability must be considered, as responses vary across plant taxa. Integrating light and water management allows for predictive control of plant development, promoting both physiological health and aesthetic quality.

Several research gaps remain. Long-term studies on growth cycles, interactions with additional environmental factors (temperature, humidity, nutrient availability), and effects of light quality (spectral composition) are limited. There is also a lack of comparative studies across a broad range of indoor ornamental species. Addressing these gaps will enhance understanding of environmental regulation and inform evidence-based indoor horticultural practices.

Technological advances, such as smart lighting systems and automated irrigation, offer potential for precision management. LEDs provide controllable light spectra, intensities, and photoperiods, while sensor-based irrigation ensures optimal soil moisture, minimizing stress and maximizing growth. These innovations facilitate the application of scientific knowledge from controlled studies to practical indoor horticulture.

CONCLUSION AND RECOMMENDATIONS

This review highlights the critical roles of light intensity and irrigation in regulating the growth and lateral spread of indoor ornamental plants. Medium light combined with moderate irrigation provides optimal conditions for biomass accumulation, leaf expansion, and lateral growth, whereas extreme conditions induce physiological stress, stunted growth, and reduced aesthetic quality.

Recommendations

1. Growers should prioritize moderate light and irrigation levels tailored to specific species requirements.
2. LED lighting systems can be employed to adjust spectral composition and intensity to optimize growth.
3. Automated or sensor-based irrigation systems should be considered to maintain optimal soil moisture.
4. Future research should examine long-term growth responses, species-specific adaptability, interactions with other environmental factors, and comparative studies across diverse ornamental species.

By following these recommendations, indoor horticulturists can maximize plant health, aesthetic value, and sustainability, while minimizing stress-related disorders.

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