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Impact of polyhouse cultivation on yield, microclimate, and profitability: A comparative study with open-field farming

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Abstract
This review explores the impact of polyhouse and open-field environments on the production parameters and economic feasibility of cultivating marigold and chrysanthemums. The study analyses factors such as irrigation, temperature, humidity, light intensity, and CO2 levels while also evaluating economic returns. Findings indicate that polyhouse conditions offer enhanced environmental control, leading to improved yield, resource efficiency, and financial viability compared to open-field cultivation.

Keywords: Chhani, consumption, fuel-wood, households, Lanchaan

Introduction

Floriculture is an essential component of modern agriculture, contributing significantly to the ornamental plant industry and commercial flower production. The cultivation of flowers such as marigold (*Tagetes erecta*) and chrysanthemum (*Chrysanthemum morifolium*) is widely practiced in both polyhouse and open-field environments. While open-field cultivation remains a conventional method, polyhouses have gained popularity due to their ability to provide controlled environmental conditions that optimize plant growth and yield.

Polyhouses regulate key microclimatic factors such as temperature, humidity, light intensity, and CO2 concentration, all of which directly influence plant development and productivity. The adoption of polyhouse technology is particularly advantageous in regions where climatic variability poses challenges to consistent flower production. By mitigating extreme temperature fluctuations, conserving water, and enhancing CO2 availability, polyhouses create an ideal setting for floriculture. However, the economic viability of these structures remains a crucial consideration for farmers and agripreneurs.

This review critically examines the differences in production parameters and economic feasibility between polyhouse and open-field cultivation of marigold and chrysanthemum. It evaluates irrigation efficiency, temperature regulation, humidity control, light intensity, and CO2 levels in both systems, alongside a financial assessment of yield and profitability. By analysing these factors, the study aims to provide insights into the benefits and challenges associated with polyhouse farming, offering guidance for sustainable agribusiness practices in floriculture.

Research

Production Parameters in Polyhouse and Open-Field Cultivation

Irrigation and Weeding: The controlled environment of a polyhouse reduces water consumption and maintenance efforts. Marigold and chrysanthemum crops required irrigation every 16 days in the polyhouse, compared to every 24 days in the open field. Similarly, weeding frequency in the polyhouse was significantly lower, occurring only four times over four months, whereas the open field required eight weeding sessions in the same period. Studies by Alam and Rahman (2022) [1] emphasize the efficiency of modern irrigation techniques, particularly drip irrigation, in conserving water and promoting plant health.

Temperature Regulation

The polyhouse maintained a temperature range of 19.2°C to 28.3°C, significantly lower than the open field, where temperatures fluctuated between 33.4°C and 37.3°C during peak summer months. Mukazhanov *et al.* (2017) [7] highlighted the influence of temperature on crop yield, indicating that optimal temperature control (18.5–29.5°C) in polyhouses facilitates better plant growth and productivity.

Humidity Levels

Humidity levels were consistently higher in the polyhouse, particularly in August when maximum humidity reached 99%. The average humidity levels in the polyhouse ranged from 57.2% to 80%, compared to 52.75% to 71% in the open field. Johnson and Patel (2023) [5] demonstrated that controlled humidity (fluctuating between 55% and 85%) in enclosed environments significantly impacts plant growth and moisture retention.

Light Intensity

Polyhouses exhibited lower light intensity compared to open fields, particularly during August and September. The open field recorded light levels between 26,370.5 and 63,776.0 Lux, whereas the polyhouse had an average range of 21,962.5 to 61,365.2 Lux. Research by Thompson and Lee (2023) [8] suggests that polyhouses, while providing a controlled environment, may not always match the optimal light intensity required for maximum photosynthesis and crop yield.

CO2 Levels

CO_2 concentration in polyhouses was consistently higher than in the open field, with levels ranging between 517 ppm and 665.2 ppm, compared to 426.75 ppm to 600.7 ppm in open conditions. Studies by Garcia and Chen (2023) [3] indicate that higher CO2 levels (525.5 to 680.5 ppm) enhance photosynthesis, leading to increased crop productivity.

Microclimate Comparison: Statistical Analysis

A t-test analysis revealed significant differences in environmental parameters between the polyhouse and open field. Temperature was consistently higher in polyhouses, with significant p-values (0.01) in September and October. Humidity levels showed significant variations (p-values of 0.06 and 0.03 in August and September, respectively). Light intensity was significantly higher in open fields, with a p-value of 0.03. Similarly, CO2 concentrations varied significantly, particularly in September and October (p-values of 0.04 and 0.03). Kumar and Singh (2022) [6] highlighted the advantages of controlled temperature and humidity in polyhouses, facilitating off-season cultivation and improving yield quality.

Economic Feasibility of Polyhouse and Open-Field Cultivation

A financial assessment comparing polyhouse and open-field cultivation analyzed total production costs, gross returns, net returns, and benefit-cost ratios (BCR). Results indicated that the polyhouse model yielded a significantly higher BCR of 12.94 (gross return: ₹3250, net return: ₹251), compared to an open-field BCR of 1.14 (gross return: ₹1600, net return: ₹-1401). Excluding land rent, the BCR for polyhouses was 2.2, while the open field recorded a negative BCR of -7.4. Bijalwan *et al.* (2017) [2] also observed higher BCRs in polyhouse floriculture, with values ranging from 1.89 to 2.39 for marigolds, as opposed to lower BCRs for other open-field flower crops.

Production Yield Analysis

Marigold and chrysanthemum yields were significantly higher in polyhouses, with marigold production reaching 10 kg (100% increase over open-field yields of 5 kg). Chrysanthemum production in polyhouses was 7 kg, a 250% increase compared to the 2 kg yield in open fields. Hinai *et al.* (2022) [4] reported similar trends in marigold cultivation, emphasizing that controlled environments enhance production efficiency. In India, key marigold-producing states contribute substantially to national output, with polyhouse production surpassing open-field yields in several regions.

Conclusion

The findings of this review highlight the advantages of polyhouse farming over open-field cultivation in terms of resource efficiency, climate regulation, and economic feasibility. Polyhouses offer a controlled environment that enhances irrigation efficiency, maintains optimal temperature and humidity levels, and increases CO2 concentration, all contributing to improved crop yield and financial viability. The economic analysis further underscores the profitability of polyhouse farming, making it a sustainable choice for agripreneurs looking to optimize floral crop production.

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