

**"COMPARATIVE ANALYSIS OF THE GROWTH AND  
DEVELOPMENT OF BASIL (OCIMUM BASILICUM) UNDER  
HYDROPONIC AND TRADITIONAL CULTIVATION CONDITIONS"**

**Abdumalikova Zarnigor Komil qizi**

**Teacher at Tashkent Vocational and Medical College**

**Abstract**

This study investigates the comparative growth and development of basil (*Ocimum basilicum*) cultivated under hydroponic and traditional soil-based methods. Morphological traits, physiological parameters, and yield performance were assessed over an 8-week growth period. The results indicate that hydroponic cultivation significantly enhanced plant height, leaf area index, and fresh biomass yield compared to traditional methods. The findings highlight hydroponics as a sustainable alternative for basil production, offering improved growth rates, efficient nutrient use, and reduced water consumption.

**Keywords:** *Ocimum basilicum*, hydroponics, soil cultivation, growth analysis, plant physiology, sustainable agriculture.

**Introduction**

Basil (*Ocimum basilicum* L.) is a herb belonging to the Lamiaceae family, known for its unique aromatic properties, rich biochemical composition and medicinal value, and is widely used worldwide in culinary, pharmaceutical and essential oil production [1]. In recent years, the increasing demand for high-quality and environmentally friendly basil products has led to the need for advanced cultivation technologies.

Hydroponics is a method based on growing plants in nutrient solutions instead of soil, which allows for efficient use of water and nutrients, increased productivity and sustainable production throughout the year [2]. This technology has advantages over traditional methods by delivering an optimal nutrient balance to plant roots and reducing the risk of soil-borne pests and diseases [3].

Previous studies have shown that basil plants grown hydroponically grow faster, have larger leaf area, and achieve higher biomass [4, 5]. However, hydroponic systems also have higher initial costs and maintenance requirements [6].

The aim of this study was to conduct a comparative analysis of basil (*Ocimum basilicum*) growth and development under hydroponic and conventional soil conditions, and to determine which method is more effective by comparing morphological, physiological, and yield parameters.

### Morphological Parameters

The growth measurements indicated that basil plants cultivated hydroponically demonstrated superior morphological development compared to those grown in traditional soil-based systems. At the end of the 8-week cultivation period, the average plant height in the hydroponic system reached  $38.5 \pm 1.2$  cm, whereas soil-grown plants averaged  $31.2 \pm 1.5$  cm. The number of leaves per plant was also higher in the hydroponic treatment (average 56 leaves) compared to the soil treatment (average 43 leaves). Leaf Area Index (LAI) measurements revealed a significant difference, with hydroponic plants reaching 3.8, while soil-grown plants recorded 2.9 ( $p < 0.05$ ).

These differences can be attributed to the constant and optimal nutrient availability in the hydroponic solution, which ensures uninterrupted vegetative growth [2,4].

### Physiological Parameters

Chlorophyll content, measured using SPAD meters, was markedly higher in hydroponic plants (45.7 SPAD units) compared to soil-grown plants (38.4 SPAD units). This higher chlorophyll concentration suggests enhanced photosynthetic efficiency in hydroponically grown basil, likely due to improved nitrogen and magnesium uptake from the nutrient solution [1,5]. Relative water content (RWC) was also higher in hydroponic plants (88%) than in soil-grown plants (80%), indicating better plant water status and reduced water stress.

### Yield Performance

Fresh biomass yields in the hydroponic system averaged  $520 \text{ g/m}^2$ , representing a 32% increase compared to the soil system ( $395 \text{ g/m}^2$ ). Similarly, dry biomass yields were significantly higher in hydroponic plants ( $62.4 \text{ g/m}^2$ ) than in soil-grown plants ( $48.1 \text{ g/m}^2$ ). The increased yield in hydroponics is consistent with earlier studies showing that controlled nutrient delivery systems optimize plant metabolic processes and biomass accumulation [3,6].

Moreover, the uniformity of growth and reduced occurrence of pest and disease problems in the hydroponic system contributed to better marketable yield quality.

### Discussion of Comparative Advantages

The findings clearly demonstrate that hydroponics offers multiple agronomic advantages over traditional soil cultivation for basil. Enhanced morphological and physiological performance under hydroponics is primarily linked to:

Controlled nutrient supply and pH regulation,

Increased oxygen availability to roots,

Elimination of soil-related constraints such as salinity and compaction.

However, it is important to note that hydroponics requires a higher initial capital investment, specialized equipment, and technical expertise [1,6]. For small-scale farmers in developing regions, the economic feasibility should be carefully evaluated before adoption. In contrast, soil cultivation remains less resource-intensive and more adaptable to open-field conditions, albeit with lower productivity.

These results align with the conclusions of Sambo et al. [4] and Walters & Currey [5], who reported that hydroponically grown basil plants not only achieve higher yields but also maintain superior leaf quality and essential oil content.

#### Conclusion

Hydroponic cultivation of basil significantly improved plant growth, physiological parameters, and yield compared to traditional soil cultivation. This method represents a sustainable and resource-efficient alternative, especially for high-value crops like basil in controlled environments.

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