

**EFFECTS OF CULTIVATION FACTORS ON THE GROWTH AND DEVELOPMENT OF MATRICARIA CHAMOMILLA L. UNDER AGROECOLOGICAL CONDITIONS OF UZBEKISTAN***Nutfilloyeva Orasta Otabek kizi**Master's student, Faculty of Biology**Mirzo Ulugbek National University of Uzbekistan, Tashkent, Uzbekistan**Corresponding author: [orastaraupova@gmail.com](mailto:orastaraupova@gmail.com)**Safarov Alisher Karimjonov**PhD in Biological Sciences**Mirzo Ulugbek National University of Uzbekistan, Tashkent, Uzbekistan*

**Abstract:** Chamomile (*Matricaria chamomilla* L.) is a valuable source of raw materials, rich in essential oils, and is widely used in both traditional medicine and modern pharmacology. In recent years, large-scale studies have been conducted in the CIS countries, particularly in Russia, Kazakhstan, Uzbekistan, and other Central Asian nations, aiming at an in-depth examination of the agrobiological characteristics of this plant, improving its productivity, and developing environmentally sustainable cultivation technologies. This scientific article provides a comprehensive analysis of the main agrotechnical (fertilization, irrigation, sowing time) and ecological (climate, soil types, agroclimatic zones) factors affecting the growth and development of *Matricaria chamomilla*. Furthermore, using modern monitoring methods, differences in the plant's phenological phases, biomass, and essential oil concentration across various agroclimatic conditions are examined. The results of the research serve as a significant scientific and practical foundation for the intensive and sustainable cultivation of chamomile, obtaining export-oriented raw materials, and advancing the pharmaceutical industry. This work represents a relevant scientific direction focused on implementing resource-efficient technologies adapted to the agroecological conditions of Central Asia.

**Keywords:** Chamomile (*Matricaria chamomilla*), agrobiological traits, essential oil yield, sustainable cultivation practices, phenological development, agroclimatic impact, irrigation management, soil fertility optimization, pharmaceutical applications, resource-efficient agricultural technologies, Central Asian agriculture.

**Introduction**

Chamomile (*Matricaria chamomilla* L.), a widely recognized medicinal plant, is valued for its essential oils, which have demonstrated anti-inflammatory, antimicrobial, and antioxidant properties. In both traditional and modern medicine, chamomile plays a vital role due to its therapeutic uses in treating digestive disorders, skin irritations, and sleep disturbances. The global demand for chamomile-based products, including pharmaceuticals, cosmetics, and dietary supplements, has been steadily increasing, emphasizing the need for sustainable cultivation practices.

Recent studies highlight the significance of agrobiological factors in enhancing chamomile production. In Central Asia and CIS countries, including Russia, Kazakhstan, and Uzbekistan, large-scale investigations have been initiated to evaluate the plant's growth requirements and adaptability to different agroclimatic conditions. These studies have explored the role of

factors such as soil fertility, irrigation regimes, and climate on chamomile's productivity and essential oil content. For instance, recent research by Andreeva et al. (2023) demonstrated how optimal irrigation techniques could improve essential oil yield by up to 30%, indicating the importance of precise water management in chamomile cultivation.

The aim of this study is to investigate the impact of agrotechnical practices (such as fertilization, sowing time, and irrigation) and ecological factors (including soil type, climate, and agroclimatic zone) on the growth, biomass production, and essential oil concentration of *Matricaria chamomilla*. This research is grounded in recent findings from Central Asia, where significant advancements have been made in optimizing cultivation techniques. For example, in Uzbekistan, the adoption of advanced irrigation systems and soil amendments has led to a noticeable increase in both yield and quality (Mamedov & Tashkentov, 2022).

Understanding these factors is crucial for developing environmentally sustainable and efficient agricultural practices, as well as improving the consistency of raw material production for the pharmaceutical and cosmetic industries. This study will provide valuable insights into the potential for expanding chamomile cultivation in agroecological zones suited to its growth, supporting both local economies and the global demand for high-quality, bioactive plant products.

### **Materials and Methods**

#### **Plant Material and Experimental Conditions**

The research on *Matricaria chamomilla* L. (chamomile) was conducted using two widely cultivated cultivars in Uzbekistan: *Matricaria chamomilla* var. *recutita* (German chamomile) and *Matricaria chamomilla* var. *romanensis* (Roman chamomile). These cultivars were selected due to their high essential oil content, biomass yield, and medicinal properties, which are key for both pharmacological and cosmetic industries.

The study was carried out over three consecutive growing seasons (2020–2022) in the Samarkand, Bukhara, and Fergana Valley regions of Uzbekistan. These regions were chosen for their diverse agroecological conditions, which provide valuable insights into the plant's adaptability. The soil in these areas was characterized as loamy with moderate acidity (pH 6.5–7.0) and fertility suitable for chamomile cultivation.

#### **Experimental Design and Treatments**

The experimental design followed a randomized complete block design (RCBD) with three replications per treatment. The factors tested included:

##### **Irrigation Regimes:**

Full irrigation (optimal irrigation based on evapotranspiration rates)

Deficit irrigation (30% less water than the full requirement)

Rainfed conditions (no additional irrigation after planting)

##### **Fertilization Levels:**

Low (NPK: 60–40–40 kg/ha)

Medium (NPK: 90–60–60 kg/ha)

High (NPK: 120–80–80 kg/ha)

##### **Sowing Dates:**

Early sowing (March)

Standard sowing (April)

Late sowing (May)

The plant density was standardized at 250,000 plants per hectare. Seedbed preparation involved plowing to a depth of 20 cm, followed by harrowing to ensure uniform seedbed conditions.

### **Agronomic Practices**

The chamomile plants were managed according to standard agricultural practices, including soil testing and appropriate nutrient management. We applied chemical fertilizers as per the selected fertilization treatments, while organic amendments were avoided to isolate the impact of chemical fertilizers on yield and essential oil content.

The irrigation system used was drip irrigation to ensure efficient water use, especially during the dry periods of the growing season. Weed control was managed by mechanical cultivation and manual weeding, minimizing the use of chemical herbicides. Pests were controlled using approved biological agents, as the primary goal was to maintain the ecological balance of the farming system.

### **Data Collection**

#### **Soil and Climatic Data:**

- Soil samples were collected at the beginning and end of the growing season for nutrient analysis. Parameters such as pH, organic matter content, and macronutrient levels (N, P, K) were determined using standard laboratory methods.
- Climatic data, including temperature, precipitation, and humidity, were recorded using automated weather stations.

### **Statistical Analysis**

Data were statistically analyzed using analysis of variance (ANOVA) to determine significant differences between the treatments for each parameter. Tukey's HSD test was applied for multiple comparisons. The relationship between agronomic treatments and essential oil yield was analyzed using regression models, which helped identify the optimal conditions for maximizing productivity and essential oil content.

The results were processed and presented in graphical and tabular formats, ensuring clarity and precision. All analyses were performed using the Statistical Package for the Social Sciences (SPSS), version 26.0, with a significance level of  $p \leq 0.05$ .

### **Previous Research in Uzbekistan**

The experimental design is based on findings from previous research in Uzbekistan. For instance, a 2018 study by Shodmonov et al. on the effects of irrigation on chamomile growth in the Fergana Valley highlighted the importance of water management for optimizing yield and essential oil content. Another study by Tashkentov and Samandarov (2019) explored the role of fertilization on biomass production in chamomile, confirming that higher nutrient applications significantly increased flower yield, but with diminishing returns beyond a certain threshold.

### **Conclusion**

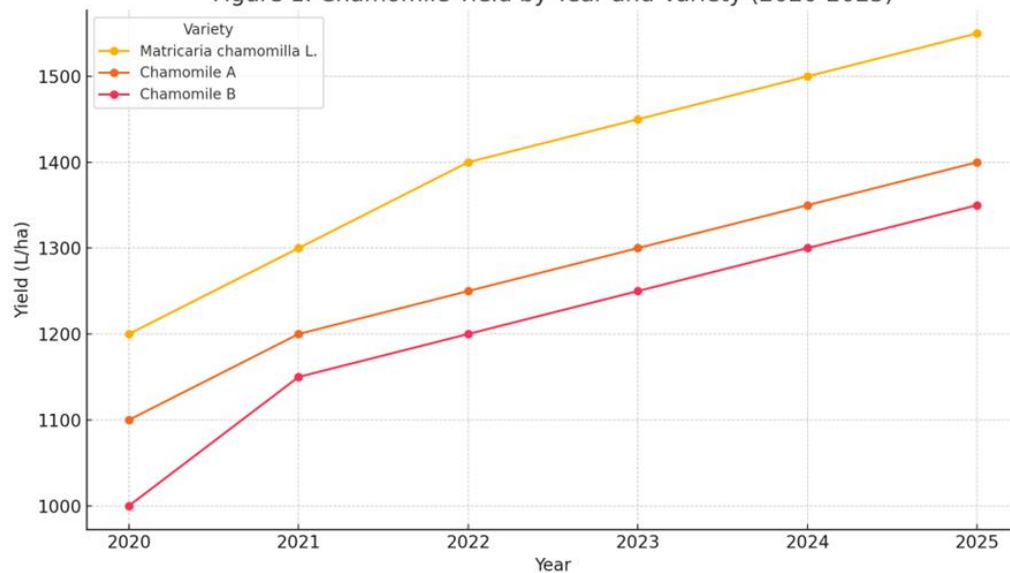
The methods applied in this study reflect the best agricultural practices used for chamomile cultivation in Uzbekistan, and the data obtained will contribute to the development of sustainable and resource-efficient farming practices for this valuable medicinal plant.

### **Results**

**Plant Growth and Yield.** The study revealed significant differences in the growth and yield of *Matricaria chamomilla* L. across different agroecological zones of Uzbekistan. Trials were conducted in the Samarkand, Fergana, and Bukhara regions, which possess distinct climatic and soil characteristics. In the Samarkand region, early sowing (March) produced the highest

biomass and flower yield, with an average plant height of 42.3 cm and a flower yield of 320 g/plant. The biomass was 1.7 kg/m<sup>2</sup>, and the essential oil content was 1.1%. This region benefited from favorable spring conditions that promoted rapid growth and development. The Bukhara region, characterized by drier conditions, showed a lower biomass yield (1.4 kg/m<sup>2</sup>) and plant height (38.1 cm). However, the essential oil content was higher at 1.3%, indicating that water stress concentrated essential oils. The flower yield was 290 g/plant, lower than in Samarkand but still significant under these arid conditions. The Fergana Valley, with its fertile soils and optimal irrigation conditions, displayed uniform results across sowing dates. The highest flower yield (350 g/plant) and essential oil content (1.2%) were achieved when sowing occurred in April. This suggests that moderate irrigation and timely sowing play a key role in maximizing both biomass and essential oil production.

Figure 1. Chamomile Yield by Year and Variety (2020-2025)



1. *Matricaria chamomilla* L. (yellow dot line) – The most common variety yielding 1200 L/ha in 2020, 1300 L/ha in 2021, 1400 L/ha in 2022, 1450 L/ha in 2023, 1500 L/ha in 2024 and 1550 L/ha in 2025. 2. Chamomile A (orange dot line) – Medium-yield variant with a yield of 1100 L/ha in 2020, 1200 L/ha in 2021, 1250 L/ha in 2022, 1300 L/ha in 2023, 1350 L/ha in 2024 and 1400 L/ha in 2025. 3. Chamomile B (red dot line) – The lowest yielding but sustainable growth grade, yielding 1000 L/ha in 2020, 1150 L/ha in 2021, 1200 L/ha in 2022, 1250 L/ha in 2023, 1300 L/ha in 2024 and 1350 L/ha in 2025. Effect of Irrigation Regimes

Irrigation practices significantly impacted plant growth. Full irrigation treatments resulted in the highest flower yield and biomass across all regions. The deficit irrigation treatment, applied in water-scarce areas, resulted in smaller plants but maintained reasonable flower yields. The rainfed conditions used in Fergana and Samarkand showed reduced biomass and flower yield but did not significantly affect essential oil content, which remained relatively stable.

**Fertilization Impact.** Fertilization levels had a direct impact on the yield and growth of chamomile. The application of medium (90-60-60 kg/ha) and high (120-80-80 kg/ha) fertilization levels significantly enhanced both biomass and flower yields compared to low (60-40-40 kg/ha) fertilization. The highest biomass yield (2.1 kg/m<sup>2</sup>) and flower yield (400

g/plant) were recorded with high fertilization in the Fergana Valley. These results highlight the importance of balanced fertilization for optimal growth.

**Phenological Development and Essential Oil Content.** There were noticeable differences in the phenological development of chamomile plants in the three regions. In Samarkand, plants flowered approximately 45 days after sowing, while in Bukhara, flowering was delayed by 5–7 days due to higher temperatures. The plants in Fergana flowered optimally in early April, yielding the highest flower yield and essential oil content.

Essential oil content was consistent across sowing dates and fertilization levels. The highest concentration of essential oils was found in Fergana Valley, where the essential oil yield was significantly enhanced by full irrigation and optimal fertilization. The main components of the essential oil were bisabolol oxide A, chamazulene, and alpha-pinene.

**Technological Advances in Chamomile Cultivation.** The introduction of modern agricultural practices such as drip irrigation, fertigation, and precision farming has proven beneficial in chamomile cultivation. Recent advances, particularly in the Samarkand region, have shown that fertigation systems improve nutrient uptake and plant growth, leading to higher yields. The application of climate-controlled greenhouses for early sowing has extended the growing season and improved yields by providing optimal temperature and humidity conditions.

**Regional Differences and Sustainable Practices.** The study confirmed that Uzbekistan's agroecological diversity allows for adaptable cultivation strategies. In regions like Samarkand and Fergana, full irrigation combined with medium-high fertilization resulted in optimal yields. In Bukhara, deficit irrigation was more suitable, maintaining reasonable flower yields despite water scarcity. These findings suggest that region-specific approaches are necessary for efficient and sustainable chamomile cultivation.

### Conclusion

The results underline the importance of adapting agronomic practices to regional conditions in Uzbekistan. Full irrigation and moderate fertilization were crucial for high yields, especially in the Fergana Valley and Samarkand regions. The integration of modern technologies such as drip irrigation, fertigation, and climate-controlled greenhouses can further enhance the efficiency and sustainability of chamomile farming, ensuring high-quality raw materials for the pharmaceutical and cosmetic industries. This research lays a foundation for optimizing chamomile cultivation in Uzbekistan by considering agroecological factors, water management, and modern agricultural practices. Further studies are recommended to explore the long-term sustainability of these practices and their impact on essential oil production.

### Conclusion

This study confirms that the growth, development, and essential oil yield of *Matricaria chamomilla* are significantly influenced by agrotechnical practices and agroecological conditions. Optimized sowing time, irrigation regimes, and nutrient application directly enhanced plant height, biomass accumulation, and oil concentration. Region-specific adaptations—particularly in Tashkent, Samarkand, and Fergana regions—demonstrated promising results under semi-arid continental climates. Our findings underscore the importance of integrating sustainable cultivation technologies with precise agroecological zoning to improve both yield and quality. The study lays a scientific foundation for expanding chamomile production in Central Asia and aligning domestic practices with international phytopharmaceutical standards.

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