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CULTIVATION OF MINT (MENTHA L.) IN SOUTHERN UZBEKISTAN AND STUDY OF ITS GREEN MASS AND SEED PRODUCTIVITY

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Abstract.
This article examines the cultivation technology of mint (Mentha L.) under the soil and climatic conditions of southern Uzbekistan, particularly the Surkhandarya region, and investigates ways to increase its green biomass and seed productivity. The study analyzes the effects of agrotechnical measures, irrigation regimes, and fertilizer application rates adapted to the hot and arid climate of the southern region on mint vegetation. In addition, scientifically based recommendations are provided regarding the optimal timing and methods for obtaining high-quality green biomass and seeds for the production of essential oils and medicinal raw materials.

Keywords: Mint (Mentha L.), southern Uzbekistan, green biomass, seed productivity, agrotechnics, introduction, medicinal plants, essential oil, yield.

Introduction

Medicinal plants have played an important role in protecting human health since ancient times. Today, a significant proportion of pharmaceuticals produced worldwide are based on plant raw materials. In Uzbekistan, expanding the raw material base of local medicinal plants, cultivating them under cultural conditions, and processing them on an industrial scale are considered priority areas of state policy. Among medicinal plants, mint (Mentha L.) occupies a special place due to its richness in essential oils and its wide application in medicine, food production, and the cosmetic industry. Menthol and other biologically active compounds contained in mint possess antispasmodic, sedative, and antiseptic properties, which makes this plant highly valued in scientific medicine.

However, the growing demand for mint cannot be satisfied solely through natural populations, as this leads to the depletion of natural reserves and disruption of ecological balance. Therefore, the domestication of mint species and the development of cultivation technologies for high-yielding forms adapted to specific climatic conditions are considered highly relevant tasks.

The Surkhandarya region, located in the southernmost part of Uzbekistan, is characterized by a sharply continental climate, the highest heat resources in the country, and a long vegetation period. Such ecological conditions and subtropical climatic elements create great opportunities for the introduction of medicinal plants and for obtaining several harvests of green biomass per year. At the same time, extremely high temperatures, hot dry winds, low air humidity, and specific soil conditions may negatively affect plant growth, development, and seed formation.

To date, the formation of vegetative and generative organs of mint, its green biomass accumulation dynamics, and seed productivity under the extreme climatic conditions of southern Uzbekistan have not been sufficiently studied. In particular, the influence of sowing dates, irrigation regimes, and mineral fertilizer rates on biomass accumulation and seed quality in oasis conditions has not been systematically investigated.

The purpose of this research is to develop scientifically based agrotechnology for cultivating mint (Mentha L.) under the soil and climatic conditions of the Surkhandarya region, to study its bioecological characteristics, and to determine the optimal parameters ensuring high green biomass and quality seed productivity. To achieve this goal, the following tasks were set: observing phenological stages of mint development, assessing resistance to unfavorable climatic factors of the

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southern region, analyzing seasonal green biomass productivity, and evaluating the seed productivity potential of the plant.

The scientific novelty of the research lies in the fact that, for the first time, the bioecological regularities of mint growth, development, and productivity formation under the extremely hot and sharply continental climate of Surkhandarya are being determined. New scientific data were obtained regarding the influence of high temperatures and dry air on mint morphology, leaf surface formation, and seed productivity. The practical significance of the obtained results lies in the possibility of developing specific agrotechnical recommendations for obtaining high-quality raw materials (green biomass) and establishing a local seed production base for mint cultivation in the southern regions. This will contribute to import substitution of medicinal plant raw materials and increase the export potential of the country.

Researches materials and methods

The methodological basis of the study consisted of internationally and nationally recognized field and laboratory methods used in the investigation of medicinal and essential oil plants. Experimental studies were carried out under the soil and climatic conditions of the Surkhandarya region in specially designated research plots. Varieties and samples belonging to the genus Mentha L. were selected as research objects.

The organization of field experiments, determination of replications, and plot placement were carried out according to the methodology proposed by B.A. Dospekhov in “Methodology of Field Experiments” [3]. To determine the growth and development patterns of plants during the vegetation period, phenological observations were conducted based on the methodological recommendations developed by the Scientific Research Institute of Medicinal Plants (VILR) and the Institute of Botany of the Academy of Sciences of the Republic of Uzbekistan. The main developmental phases of mint, including germination, branching, budding, flowering, and seed ripening stages, were recorded according to calendar days.

Morphological indicators of mint, including stem height, number of leaves, internode length, and number of inflorescences, were determined by selecting sample plants diagonally from each plot and conducting biometric measurements. To evaluate green biomass productivity, which is considered one of the most important economic characteristics of the plant, mint was harvested during the budding and mass flowering phases. The obtained raw material was immediately weighed in laboratory conditions, and the amount of green biomass per hectare was calculated.

The dynamics of leaf surface area and photosynthetic potential were determined using mathematical and graphical methods. Essential oil content and quality analysis were performed by extracting essential oils from green biomass samples using hydrodistillation methods with Ginzberg or Clevenger apparatuses, and the oil content was expressed as a percentage.

The formation of generative organs and seed productivity were studied according to international seed testing standards and methodologies. Potential and actual seed productivity, the number of inflorescences per plant, the number of seeds per inflorescence, and the weight of 1000 seeds were determined using analytical scales. In addition, seed germination energy and laboratory germination rates were assessed under controlled temperature and humidity conditions in thermostats.

The agrochemical and agrophysical properties of the experimental soil, including humus content and the amounts of total and available nitrogen, phosphorus, and potassium, were analyzed in laboratory conditions using generally accepted chemical analysis methods such as the Tyurin, Kjeldahl, and Machigin methods.

Discussion

The results obtained from the study of green biomass accumulation dynamics and seed productivity of mint (Mentha L.) under the specific soil and climatic conditions of the Surkhandarya region were comparatively analyzed with existing scientific studies and theoretical concepts in this field. The use of B.A. Dospekhov’s methodological guidelines in planning field experiments and in the mathematical-statistical processing of biometric and productivity indicators ensured the reliability and accuracy of the obtained data ($P < 0.05$) [3]. The results of variance analysis confirmed that

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environmental factors and agrotechnical measures, including irrigation and fertilization, had a significant and reliable influence on plant growth and developmental phases. This indicates that even under the extreme climatic conditions of southern Uzbekistan, the biological potential of mint can be fully realized through the application of scientifically based agrotechnology.

The obtained green biomass productivity (annual total yield of 30–36 t/ha) was considerably higher than the results reported in previous studies conducted in the central and northern regions of Uzbekistan. This can be explained by the long vegetation period of 240–270 days and the high accumulation of effective temperatures in the Surkhandarya region. Such climatic advantages made it possible to obtain two full and high-quality harvests of green biomass during one growing season. However, during the abnormally hot months of July and August, a slight slowdown in stem growth was observed, which can be regarded as an adaptive response of the plant to extreme heat and dry air conditions. These findings are fully consistent with general botanical concepts related to the introduction and cultivation of medicinal and essential oil plants [1].

In terms of the generative development of mint, seed productivity indicators such as the weight of 1000 seeds and seed-setting capacity proved to be more sensitive to environmental factors than vegetative organs. Hot dry winds during summer reduced pollen viability, resulting in a tendency toward decreased seed productivity under open-field conditions. Nevertheless, the application of nighttime irrigation systems, which stabilized the microclimate, significantly reduced these negative effects and made it possible to obtain high-quality seed material with laboratory germination rates of 85–88% [4]. The relatively high essential oil content (2.8–3.2%) indicates that under hot climatic conditions the synthesis of secondary metabolites, including menthol and its derivatives, becomes more active. Therefore, the climatic conditions of the Surkhandarya region can be considered highly favorable not only for obtaining industrial-scale green biomass, but also for establishing a local mint seed production base [2].

Conclusion

Based on the scientific studies conducted on the cultivation of mint (Mentha L.), its green biomass accumulation dynamics, and seed productivity under the sharply continental and hot climatic conditions of the Surkhandarya region, the following conclusions were drawn:

- The high thermal resources and long vegetation period of the Surkhandarya region make it possible to obtain two harvests of high-quality green biomass from mint during one growing season. When mineral fertilizers (N150 P100 K75) and optimal irrigation regimes were applied, the annual total green biomass productivity reached 30–36 t/ha.
- Although extreme heat and dry air slightly slowed plant growth rates, they stimulated the synthesis of secondary metabolites. The essential oil content in raw material collected during the mass flowering phase reached the highest level (2.8–3.2% relative to dry mass), indicating the possibility of obtaining industrially valuable medicinal products.
- It was determined that the negative effects of hot dry winds on pollination processes can be reduced through the application of nighttime irrigation technology. Under such conditions, the actual seed productivity per plant reached 45–60 seeds, the weight of 1000 seeds ranged from 0.055 to 0.062 g, and laboratory germination rates reached 85–88%.

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