Growth, development, and yield of the usual basil (*ocimum basilicum* L.) under different cultivation conditions

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Abstract. This article presents the results of research on the study of the growth, development and productivity of different forms and varieties (*Ocimum basilicum* L.) in different growing conditions and the content of essential oils in the aboveground mass of the plant. Presowing treatment of seeds of the studied basil samples increases their germination energy and germination capacity. Changes in the content of essential oils during plant ontogenesis and growing conditions were revealed. The greatest increase in essential oils was noted during the period of mass flowering, then their decrease is observed. The maximum amount of essential oils was found in the inflorescences (0.4-2.1%), then in the leaves (0.2-0.9%), and the smallest amount (0.05-0.1%) in the stems. The forms and varieties of purple basil are distinguished by a relatively high content of essential oil. The highest yield of leaves was formed by basil with large green leaves, which significantly exceeded all other studied varieties and samples.

1 Introduction

Currently, there is a steady trend towards an increase in the use of medicinal and prophylactic herbal preparations. Due to the decrease in the natural habitats of medicinal and essential oil plants, as well as the constant increase in the need for high-quality raw materials, more and more attention is paid to their cultivation [1]. The cultivation of medicinal and essential oil plants contributes to the preservation of natural plant resources and the receipt of guaranteed raw materials [1, 2].

About 3,000 species of essential oil plants are known in the world, in Uzbekistan – 650 species. However, only 200 species are of industrial importance. The volume of production of essential oils worldwide is up to 30,000 tons per year, for which about 300 species of essential oil plants are used [3, 5].

Essential oils of certain plant species have pronounced bactericidal and fungicidal properties and are the most promising source of low-toxic antimicrobial medicines. Essential oils have a targeted therapeutic effect on the human body and can be used in the treatment of various diseases: cardiovascular, pulmonary, gastrointestinal, hypotensive, antimicrobial, antispasmodic, tonic, and anti-inflammatory medicines [1-3].

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The demand for medicines, as well as for natural essential oils, is increasing every year. In this regard, the expansion of the raw material base of essential oil plants, the study of the physiological and biochemical characteristics of promising ether carriers, the study of the seasonal and age-related dynamics of the accumulation of biologically active substances are becoming urgent problems [4, 6].

It is known that the chemical composition of a plant is subject to significant fluctuations and depends on many factors. Thus, natural and climatic factors have a decisive influence on the chemical composition of plants. It should also be noted that the features of the cultivation of essential oil plants can be identified in the process of realizing their biological potential when the growing conditions and cultivation methods change. These factors affecting plants are closely interrelated. Growing conditions help to reveal the adaptive capabilities of plants, cultivation methods - to bring them in line with the biological needs of the culture. Adaptive technologies are the result of optimally selected growing conditions and cultivation methods [4, 5, 9].

It is known that among the essential oil plants, essential oils of which are widely used in various industries, basil is of the greatest importance [9]. The need for essential oil and basil raw materials is constantly growing. In this regard, for the cultivation of common basil in order to obtain high yields of high-quality raw materials, it is necessary to use appropriate cultivation techniques [10, 11].

In this regard, the purpose of this work is to study the characteristics of growth and development, as well as the productivity of different forms and varieties of common basil in different growing conditions and the content of essential oils in the aboveground mass of the plant.

2 Materials and research methods

The objects of the study were different varieties and forms of usual basil: varieties Lemon Miracle, Siamese Queen, Moskvoretsky Semko, forms with large and small purple leaves, as well as with a green color.

Seed germination and germination energy were determined according to the Methodology of State Variety Testing of Agricultural Crops [8] and according to GOST 12038-84 [7].

Basil seeds were germinated in Petri dishes and in rolls of filter paper at a temperature of 25^0C in an ED 53 thermostat ($\pm$ 0.3 ^{0}C).

Small-plot field experiments were laid in order to study the biological characteristics of the basil. In all experiments, the sowing pattern was 60 × 20 cm, the area of the accounting plot was 3 m^2.

Phenological observations and plant care were carried out according to the VILAR methods [1-3, 11]. The yield of plants was recalculated per weight of air dry raw material. Drying of raw materials was carried out in the shade at a temperature of 40^0C.

The essential oil was obtained from the crushed mass in the process of distillation with steam using a nozzle for collecting essential oils [3, 4]. The percentage of essential oil yield was calculated relative to the dry weight of the plants.

3 Results and discussion

In this regard, at the initial stage, seed germination and germination energy were determined. The results are shown in Table 1.

Table 1. Usual basil seed germination.

#	Sample name	Experience options	Germination energy,%	Germination,%
1	Green basil with large leaves	water	46	68
2	Green basil with large leaves	solution KM_nO_4	49	78
3	Small-leaved basil of green color	water	53	82
4	Small-leaved basil of green color	KM_nO_4 solution	58	90
5	Purple basil with large leaves	water	47	76
6	Purple basil with large leaves	KM_nO_4 solution	53	84
7	Purple basil with small leaves	water	52	82
8	Purple basil with small leaves	KM_nO_4 solution	55	87
9	Lemon Miracle	water	58	90
10	Lemon Miracle	KM_nO_4 solution	60	92
11	Siamese queen	water	46	74
12	Moskvoretsky Semko	water	51	80

As can be seen from the data presented, seed germination of the studied basil samples varied from 68 to 92%. At the same time, the germination of seeds of small-leaved forms of basil was higher.

Presowing treatment of basil seeds with a 0.5% potassium permanganate solution for 5 minutes increased their germination. The germination energy of seeds of all studied basil samples in the variants treated with potassium permanganate solution was also higher than that of untreated seeds.

In the next series of experiments, pre-sowing treatment of basil seeds was carried out with Ecolarix and Extracor preparations obtained from Daurian larch [11].

The results obtained are shown in Table 2. As can be seen from the data presented, the optimal concentration of the studied stimulants for the germination of basil seeds is 100 mg/l. An increase in the concentration of stimulants leads to a decrease in their effect. The effect of growth stimulants on seed germination also depends on the shape and varieties of basil: the most sensitive forms of basil with a purple color.

Table 2. Usual basil seed germination.

Basil samples	Extracor			Ecolarix			Water
	50 mg/l	100 mg/l	150 mg/l	50 mg/l	100 mg/l	150 mg/l	
Green basil with large leaves	88	96	76	90	92	84	68
Purple basil with large leaves	84	88	92	84	96	85	76
Small-leaved basil of green color	86	90	88	88	92	74	82
Small-leaved purple basil	86	88	96	85	92	90	82
Lemon Miracle	90	96	84	84	96	85	88
Moskvoretsky Semko	82	92	88	86	95	90	80

The results of phenological observations showed that all the measured morphological parameters of plants had high values in the experimental plot of the Botanical Garden of the National University of Uzbekistan (NUUz) in comparison with urban plots. So, the greatest height was distinguished by basil plants of local reproduction with large green leaves (9-112 cm). Basil variety Lemon Miracle (68-70 cm.) was distinguished by the smallest plant height. differences between basil specimens also appeared in the width of the bush. This indicator reflects the nature of branching, which, to a certain extent, affects the formation of the vegetative mass of basil plants. The greatest width of the bush was found in basil with small leaves, the smallest width of the bush was found in the varieties Moskvoretskye Semko and Lemon Miracle. In urban conditions, due to the gas pollution of the air, especially in those that grow along highways, the rates of growth and development of plants change. There is a reduction in the growing season, flowering and seed maturation (Table 3).

Table 3. Duration of development phases of usual basil in different growing conditions (days from germination).

Place of cultivation	Sowing	Seedlings	Branching	Budding	Bloom	Maturation
Bot.garden NUUz	20.04	7-12	15-18	50-65	60-80	100-110
Room conditions	21.04	8-11	14-16	45-50	50-70	92-95
Urban conditions	21.04	8-14	12-15	43-50	50-65	80-105

Plants in indoor conditions grew quite intensively, however, in the second half of the growing season, the rates of development decreased due to insufficient illumination.

The yield of the studied culture is one of the main indicators of the efficiency of the cultivation technology. Environmental factors affect the intensity of the physiological and biochemical processes of plants, which determine the size and quality of the crop, varying over a wide range.

During the years of research, the greatest leaf productivity was formed by basil with large leaves (158-176 g), which significantly exceeded all other studied varieties and samples of basil. Basil of the Lemon Miracle variety (70-79 g) had the lowest leaf mass productivity.

Thus, the studied varieties and forms of basil under the conditions of the Botanical Garden of NUUz had a high potential for the productivity of the leafy mass, the implementation of which is limited by the growing conditions.

It is known that essential oil plants in the process of growth and development not only synthesize essential oils, but also release them into the environment. The evaporation rate of essential oils depends on the properties of the essential oils and environmental factors.

A comparative study of the content of essential oil revealed the greatest accumulation of it in basil at the end of the mass flowering. Then there is a decrease in the content of essential oil.

Relatively In a comparative study of the content of essential oil, the greatest accumulation of it was found in basil at the end of the mass flowering. Then there is a decrease in the content of essential oil.

A high amount of essential oils is contained in the inflorescences (0.43-1.28%), in the leaves (0.2-0.9%), and in the stems - a minimum of essential oil (0.05-0.1%).

We also revealed differences in the content of essential oils in the studied varieties and forms of usual basil. The forms and varieties of purple basil plants are distinguished by a relatively high content of essential oil.

Basil growing conditions also affect the content of essential oils. The largest amount of essential oils (0.43-1.29%) was found in plants from the Botanical Garden and the smallest - grown in room conditions (0.30-0.61%). Basil grown in urban conditions contained 0.33-0.86% of essential oils.

Thus, the research results showed that usual basil manages to go through the full cycle of seasonal development, has good growth potential, high reproductive capacity and can be recommended for cultivation.

4 Conclusions

Based on the results obtained, the following conclusions can be drawn:

1. Seed germination of all studied basil samples was more than 70% (varied from 68 to 92%). At the same time, the germination of seeds of small-leaved forms of basil was higher. Presowing seed treatment with potassium permanganate solution and growth stimulants increases the germination energy and germination of basil seeds.
2. The rate of growth and development of usual basil, as well as the productivity of the leaf mass, depend both on the biological characteristics of the plant and on the conditions of their growth.
3. The greatest accumulation of essential oils was found during the period of mass flowering of basil. A relatively high amount of essential oils is found in the inflorescences, then in the leaves.
4. The study of the biological characteristics of the growth of usual basil samples showed the prospects of their cultivation both as an essential oil plant and as a component of plantations for the purpose of landscaping settlements.

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