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Growth and Development of *Rosmarinus Officinalis* L. under the Oasis of Karshi

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Abstract The article presents the results of studying the growth and development of *Rosmarinus officinalis* L., introduced for the first time in the conditions of the Karshi oasis. it was determined that under the conditions of introduction, it continues its vegetation for a long time (320-330 days), in the first year of life, branching up to the second order, and 3-year-old plants enter the generative phase. It was observed that the plant belongs to the group of spring-summer-autumn-winter green phenorhythmotypes, begins vegetation in the third decade of August and continues vegetation in winter, and when the air temperature rises above +30℃, it passes into a period of summer dormancy. It is established that it is resistant to extremely high temperatures (+45℃) and a sharp drop in air (-15℃).

Keywords Rosemary officinalis, Cotyledon, True leaf, Double leaf, Shoot, Growth, Development, Vegetation, Generative phase

1. Introduction

Rosmarinus officinalis L. – rosemary officinalis is an essential oil medicinal plant belonging to the mint family, an evergreen shrub up to 1,5–2 m tall. In nature, it grows in the Mediterranean countries: on the Madeira Islands, in Algeria, Tunisia, Turkey, Lebanon, Greece, Dalmatia and nearby islands, on dry limestone slopes and sunny open ground. Cultivated in Italy, Austria, Spain, France and North America [1,2].

Green branches and leaves of the plant contain essential oils (cymol, borleol, pinene, carvacrol), a small amount of tannins and flavonoids. It is also used in the perfume, soap, dye and food industries. The plant contains a large amount of essential oils in leaves, flowers, young branches and the upper part of 3-4 year old branches [2,3,4]. The leaves of the plant are included in the British Pharmacopoeia, are the official raw material in the USA, India, China and are used in homeopathy [5]. In the North Caucasus, it is part of the combined preparations "Kanefron", "Pulmeks", "Evkabol", "Tetesept" and biologically active food supplements [6].

It was first introduced into Uzbekistan by S. N. Kudryashov (1930-36) in the Botanical Garden of the Central Asian State University (now UzMU) [1]. Later, as a valuable medicinal and essential oil plant, Yu. M. Murdakhaev (1992) re-introduced it into the Tashkent Botanical Garden [7].

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R. officinalis was first introduced in 2014 in the Karshi oasis. The seeds were brought from the Timiryazev Moscow Agricultural Academy.

The study of the growth and development of a plant under conditions of introduction serves to determine the possibility of obtaining raw materials from it as an essential oil plant [8].

2. The Purpose of the Study

Study of the growth and development of *R. officinalis* in the conditions of the Karshi oasis.

3. Research Methods

Seeds were studied according to R.E. Levina (1981) [9]. Seed germination in laboratory conditions was determined by placing 100 seeds on a filter paper moistened with distilled water in a Petri dish and at different temperatures (17-20℃, 21-24℃, 25-28℃) in a thermostat in 3 repetitions. Under the conditions of introduction, the biomorphological characteristics of the objects of study were studied according to T.A. Rabotnov (1960), I.G. Serebryakov (1952) [10,11]. Phenological observations were carried out according to the method of I.N. Beideman (1960) [12], statistical data were analyzed according to G.N. Zaitsev (1960) [13].

4. Research Results

Seeds of *R. officinalis*, obtained under the conditions of the Karshi oasis, have an oblong-ovoid shape, yellowish-brown color, smooth surface. Weight of 1000

seeds 1,23–1,49 g.

R. officinalis seeds have a short (V1) physiological dormancy period [14]. Remains viable for 6-7 years. Seed germination is high (62%) in 1-2-year-old seeds, this figure is 54% in 3-year-old seeds, 39% in 4-year-old seeds. In 6-7-year-old seeds, the percentage of germination is very low (8%), and in subsequent years it is completely lost.

Seed germination was tested in laboratory conditions and determined that the optimum temperature for seed germination is 20-22℃. At the appropriate temperature, the seeds began to germinate in 8-10 days. In all germinated seeds, first an embryonic root, and then a yellow-green cotyledon, grew from the micropili. Seed germination was 62%.

Seeds sown in the field, after 10-12 days, began to grow on the ground. The hypocotyl of the seedlings is pale pink in color and 4,2 mm long. Seed germination is aboveground, the cotyledons stick together and germinate on the ground. The seed coat remains underground. At this time, the cotyledons are thin, and the length of the reniform leaf slightly exceeds its width: its length is 1,7 mm and its width is 1,15 mm. One side of the base of the cotyledon is concave, dark green. The growth of a plant from seeds planted at the end of March begins to be felt after 5-8 days. At this time, the length of the main root will be 1,05 cm.

The 15-day-old plant has a height of 1,17 cm and developed true leaves. The first true leaves are lanceolate, slightly pointed, with straight edges, non-striated, glabrous, dark green, opposite on the stem. At this time, the cotyledon leaf becomes much larger, reaching 2,3 mm in length, 1,4 mm in width and 2,0 mm in width. The main root is 2,2 cm long and produces up to 6-8 lateral roots.

The 20-day-old plant is 1,4 cm tall and has 2-4 pairs of leaves. The next pair of leaves differ from the first true leaves to form in that they are covered with fine hairs. By this time, the cotyledon leaf reaches 3,3 mm in length, 2,3 mm in width and 2,5 mm in girth, stops growing and begins to turn yellow. The length of the main root reaches 6,1 cm, secondary lateral roots begin to develop.

Even in a monthly plant, growth and development are accelerated, and in a plant that has reached 1,5-2 cm in height, 6-7 pairs of leaves are formed, the number of segments is 2-4 (Fig. 1). At the main root, growth slows down and reaches a length of 6,9 cm, lateral roots of the third order begin to form. By this time, the cotyledons turn completely yellow and fall off in some plants.

The life span of the cotyledons is 35-45 days, the maximum size reaches 4,3 mm in length and 2,7 mm in width.

The height of a 3-month-old plant reaches 11,4 cm, and the number of segments reaches 8-9. The growth of the main branch slows down, branches of the first order form from the first segment, and the plant enters the immature stage. At this time, the height of the main branch is 11,0 cm, the length of the branches of the first order reaches 5,4 cm, and the total number of leaves on the plant reaches 30-35 pairs. At the main root, growth is slow and reaches a length of 7,8 cm; growth at lateral roots is faster (Fig. 1).

Under unfavorable conditions, due to a sharp increase in air temperature from mid-June, the growth of seedlings is sharply reduced, as a result of which the growth of the plant in the summer months is almost not noticeable.

By June, the height of the plant reaches 8-10 cm, and the number of segments reaches 8-9. By this time, branches of the 1st order will form from the initial segment of the main branch. Plant growth stops by June and resumes from the third decade of August (Fig. 1).

The segments formed in spring on the main stem of the plant are very short (0,5-0,6 cm), and the segments formed in May-June are relatively long (2-2,5 cm). The length of the segments decreases again in autumn (1-1,5 cm).

From the second decade of December, the growth of sprouts slows down due to a decrease in temperature. At this time, the diameter of the root neck reaches 0,5-0,8 cm, and the part of the stem that has grown by September is crushed. At the same time, the height of the plant was 37,0±0,3 cm, the length of the branches of the 1st order was 18,1±1,5 cm, the length of the branches of the 2nd order was 1,6±0,1 cm (Fig. 1).

There were no cases of frost damage to young seedlings that overwintered on open ground. The Karshi oasis has a favorable climate for plants, and due to the warm winter, the vegetation of *R. officinalis* is significantly accelerated from the second decade of February, and in some years its vegetation begins in the second half of January.

Information about the flowering of *R. officinalis* at the age of 2–3 years is given in the literature [1,4]. Bloomed in the third year of life in the conditions of the Karshi oasis. The generative phase begins in the second half of February in the third year of the plant's life. First, the flower is formed on the top of the main stem and on the top of the branches of the first order, and the next year on the top of the branches of the second and third order.

The plant produced 30-50 flowers in the third year of vegetation, 200-245 in the fourth year and 180-210 in the fifth year. One flower blooms 3-4 days, one inflorescence - 20-30 days, and one plant - 76-90 days [15].

In the conditions of the Karshi oasis, the beginning of flowering mainly falls on the second half of October - the beginning of March, and the full bloom - in March-April. The fruiting process was observed from March to June. In March-April, buds, flowers and fruits were simultaneously formed on one plant. The flowering period lasted 197-221 days (Fig. 2).

As a result of regular observations of the phenology of *R. officinalis*, the periods of the main phenophases were determined and the data obtained were analyzed. Accordingly, the plant belongs to the autumn-winter-spring evergreen type of the spring-summer-autumn-winter green phenorhythmotypic group with a summer dormant period, the vegetation of which begins in summer, from the third decade of August, and ends in June of the next year, and the duration of vegetation lasts 9-10 months.

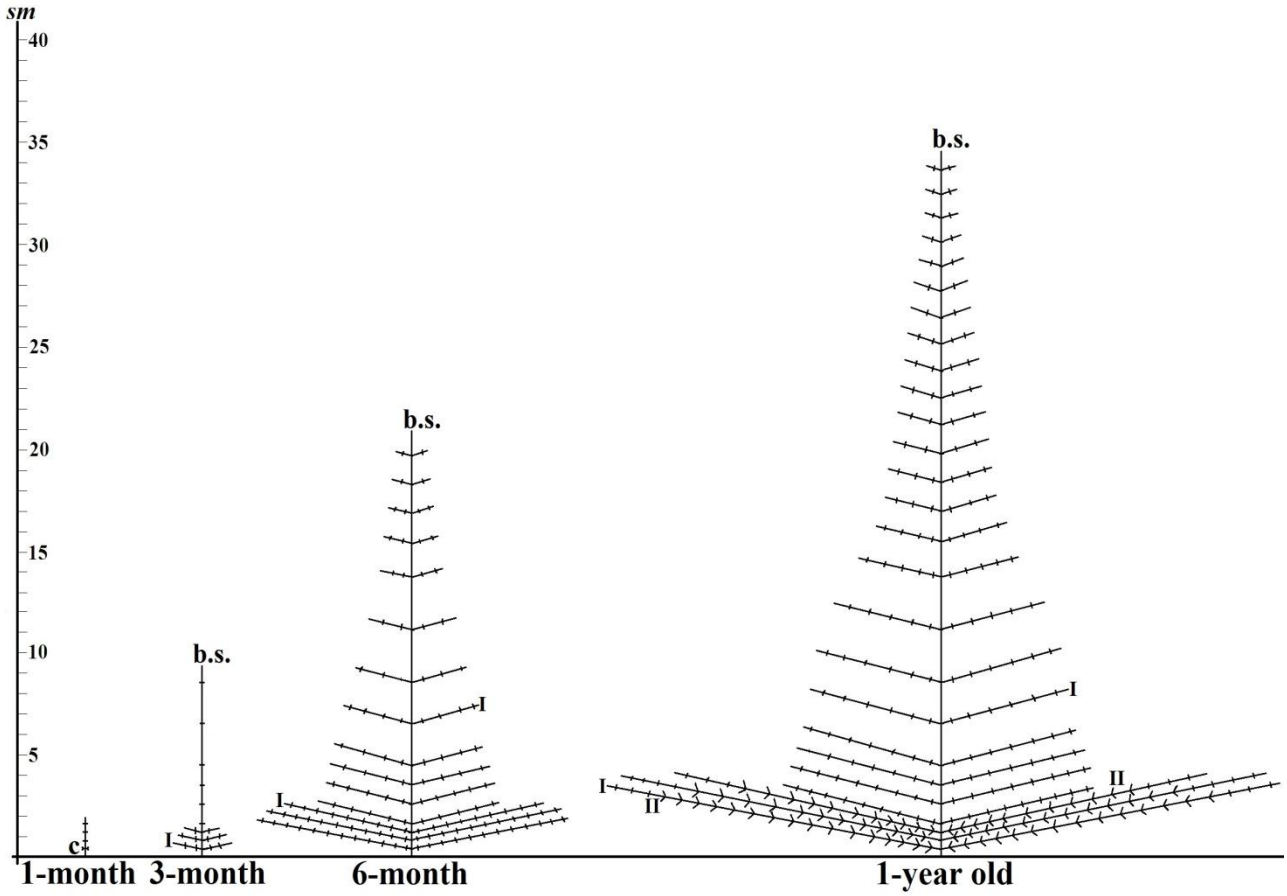

Figure 1. Growth and development of *R. officinalis* in the first year of life: Commentary: b.s. - basic stem; c - cotyledon; I - first order branching, II - second order branching

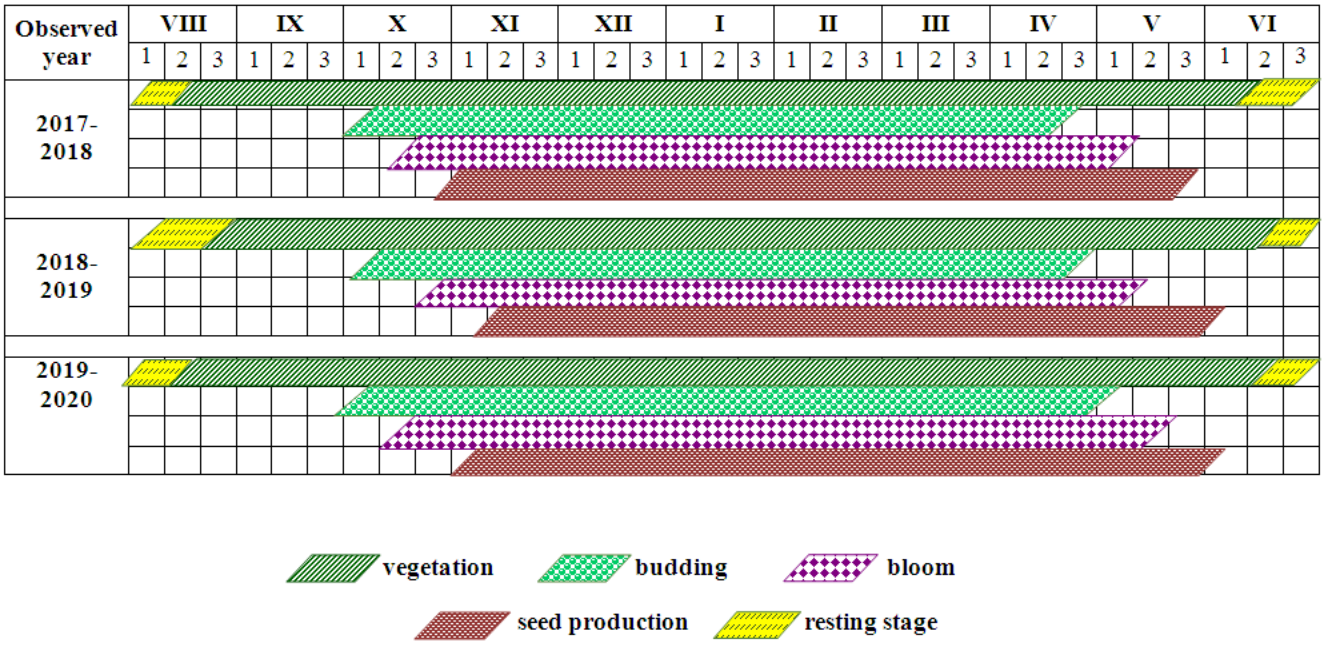

Figure 2. Phenospectrum of *R. officinalis* in Karshi oasis

S.N. Kudryashov (1936) believed that *R. officinalis* should be planted and tested in arid regions. It was introduced in the UzFA Botanical Garden, and under these conditions it was found that it grows well on arid lands with sandy loam,

gravel and sand, and is not picky about soil fertility [1,2].

According to A. Rehder (1947), fully frost-resistant plants are included in the VI climatic zone, and R. officinalis belongs to the VI climatic zone [16].

R. officinalis, grown in the conditions of the Karshi oasis, during the years of research (2017-2020) showed cold resistance and continued its vegetation as a green plant in winter. 2018 (28.01) was not affected by frost even at the lowest observed temperature (–15℃).

In the years of observations (2017-2020), *R. officinalis* completed its vegetation in the first ten days of June. With an increase in air temperature from +25℃, the growth of seedlings begins to slow down significantly, and when +30℃ is exceeded, the vegetation stops. In May 2018 (10.05), as a result of a sharp increase in air temperature and an increase in temperature to +41℃, the growing season ended earlier than in other years.

5. Conclusions

In the conditions of the Karshi oasis, R. officinalis intensive growth and development was noted, the entry into the generative period at the age of 3 and a long growing season (320-330 days) were noted.

It is noted that it finishes vegetation in the autumn-winter-spring months, belongs to the group of spring-summer-autumn-winter green phenorhythmotypes, begins vegetation in August, begins flowering in autumn, begins mass flowering in early spring and enters the summer dormant period when the air temperature rises above +30℃.

It was determined that seedlings grown from seeds grow well in the conditions of the Karshi oasis, are resistant to extremely hot (+45℃) and dry summer conditions of the Karshi oasis, as well as to a sharp decrease in air temperature (–15℃) in winter.

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