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CHANGES OF NUCLEIC ACIDS OF WHEAT SEEDLINGS UNDER SPACEFLIGHT CONDITIONS

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16. Abstract

The effects of space flight on the growth of wheat seedlings and their nucleic acid content were studied. It was shown that both space and ground seedlings have almost the same appearance, dry weight and nucleic acid content in the root, coleoptile and leaves. The only difference found is in the RNA and DNA content, which is twice as much in the ground seedling apices as in the space-grown seedlings.

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CHANGES OF NUCLEIC ACIDS OF WHEAT SEEDLINGS UNDER SPACEFLIGHT CONDITIONS

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Many month and many year flights of space stations is the closest to reality in space research. In connection with this, the next priority is the problem of creation of closed life support systems, the basic portion of the phytoautotrophic chain of which may be higher plants. /76*

Studies conducted in orbit have shown that the germination of seeds, the first phases of growth and growth of seedlings occur without observable deviation [1-3]. In continuous cultivation under space flight conditions however, plants do not complete the full growth cycle but, after rapid depression of their growth, they die. Changes in content of some substances also are observed between the test and control plants [2]. Thus, in the leaves of test pea and wheat plants after 24-33 days growth in orbit, the chlorophyll and xanthophyll content changed by 30-35% compared with the control, albumen by 15%, cellulose by 50%, starch by 32%, and the carotenoid, monosaccharide and hemicellulose content increased by 26, 29 and 11% respectively.

Why the plants die in space has not been explained yet, although many investigators consider the absence of gravity to be the immediate cause of this phenomenon. Moreover, the depression of plant growth in orbit may be due to partial anaerobiosis during seed germination and development of the root system, limited gas exchange and deterioration of transpiration of the leaves due to the lack of active ventilation. It is likely that space conditions cause severe changes in the metabolic, transport, uptake and secretion functions of the

*Numbers in the margin indicate pagination in the foreign text.

plant organism. In connection with this, joint studies of specialists in different fields are required, such as comparative studies of plants before and after a flight in space, and in comparison of "space" plants with analogs which grew under earth conditions all this time.

We studied the effect of space flight on the growth of wheat and the nucleic acid content of its organs. Plants were cultivated aboard the Salyut-6 orbital station and in a chamber on the ground in a nutrient substrate in Oasis containers with watering and illumination systems for 18 days. Ground test plants in laboratory conditions and the "space" plants at the Soyuz-34 descent vehicle landing site were fixed in 96 proof ethyl alcohol for subsequent nucleic acid determination. The total RNA and DNA content of the abovementioned materials was determined after alkaline hydrolysis, by measuring the absorption of purine and pyrimidine bases in the ultraviolet with a SF-16 spectrophotometer [4, 5].

It was determined that the space and ground plants hardly differed in outward appearance and mass. In the test period, both formed four leaves of practically equal length, and the mass of dry matter of a single plant from space, acquired a total mass of the apices, leaves and coleoptiles of 20 mg, and that of the ground analog was 23 mg (Fig. 1). /77

The relative (per g of dry, withered material) content of RNA and DNA in the roots, coleoptiles and four leaves actually were the same in the test and control versions. Only the apices of the wheat plants grown under space flight conditions differ appreciably in nucleic acid content from the apices of wheat grown under similar conditions on the ground. Half as much RNA and DNA was found in the apices of the space wheat (Fig. 2).

The data obtained are insufficient to establish a clear relationship between flight conditions and the quantitative nucleic acid content. However, it can be assumed that the mechanism of removal of

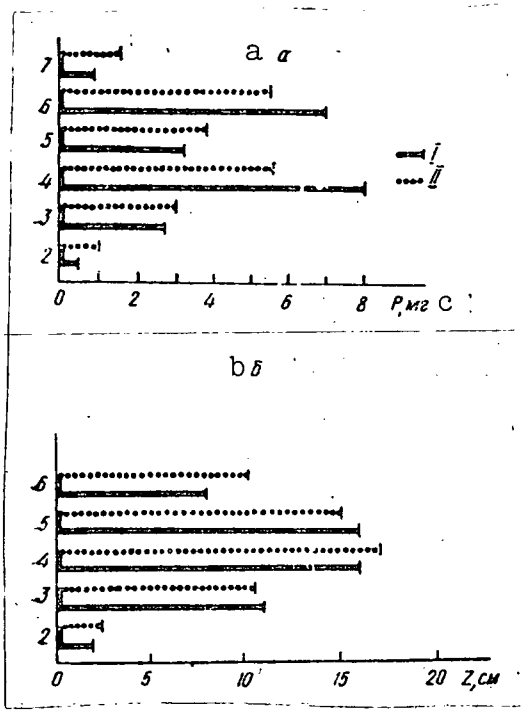

Fig. 1. Effect of space flight conditions on growth of elements of wheat seedlings: a. dry matter content, mg; b. leaf length, cm; I. Earth; II. Space; 1. root; 2. coleoptile; 3-6. 1st, 2nd, 3rd and 4th leaves, respectively; 7. apex.

Key: c. P, mg

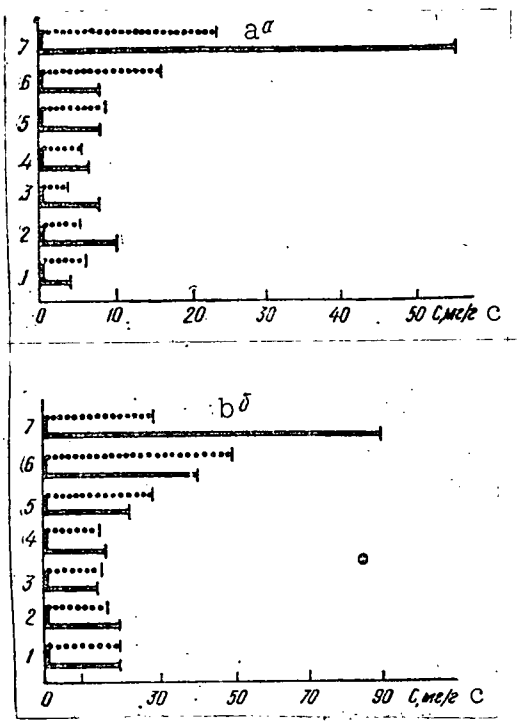

Fig. 2. DNA (a) and RNA (b) content of elements of wheat seedlings: designations same as in Fig. 1.

Key: C, mg/g

the products of the vital activities of the plants, which are returned to environment which surrounds the root system and causes accumulation of their product, is stimulated under space conditions. In this case, in early stages of growth the development of the plant and metabolism of such physiologically active compounds as nucleic acids evidently are similar in wheat seedlings on the ground and in space, until the products of the vital activities of the root systems accumulate in inhibiting quantities, which results in stimulation of metabolism, first in the active regions (tissues), which correspond to new formation of plants (in the apices in our case).

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