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BIOLOGICAL CHARACTERISTICS AND IMPORTANCE OF THE SOYBEAN (*GLYCINE MAX*)

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Article. The article examines the biological characteristics, significance, cultivation, and breeding of soybean (*Glycine max*). Soybeans, due to their high protein and oil content, are widely used in the food industry, medicine, agriculture, and industrial production. Particular attention is paid to its role in enriching soil with nitrogen and promoting sustainable agriculture. The botanical characteristics of the plant, including its structure, biological features, and adaptability, are discussed. Key aspects of soybean cultivation, such as climate requirements, soil conditions, agronomic practices, and yield, are analyzed. The focus is also on breeding efforts aimed at enhancing stress resistance, improving seed quality, and increasing productivity. In Uzbekistan, soybeans play an important role in the agricultural sector, serving as a source of vegetable oils and feeds, as well as contributing to soil fertility improvement through crop rotation. The significance of implementing modern technologies and breeding advancements to boost yields and enhance the country’s export potential is emphasized.
Key words: soybean (*Glycine max*), biological characteristics, cultivation, breeding, food security, plant proteins, sustainability, agriculture, Uzbekistan, nitrogen fixation, agricultural technology, export potential.

Introduction

Soybean (*Glycine max*) is one of the most important agricultural crops, widely used around the world. Thanks to its unique combination of high protein content (up to 40%) and oils (around 20%), it is valued both in food and industrial processing. Soy-based products, such as oil, meal, flour, and protein isolates, are used in the production of food products, animal feed, biofuels, and pharmaceuticals.

The origin of soybeans is linked to East Asia, where the crop has been cultivated for over 4,000 years. Today, its main producers are the United States, Brazil, Argentina, and China, with global soybean production exceeding 350 million tons annually [9]. In recent decades, soybeans have gained critical importance for ensuring food security, especially in regions with intensive livestock farming.

The cultivation of soybeans in Central Asia, particularly in Uzbekistan, is of special interest. This crop not only enriches soils through symbiosis with nitrogen-fixing bacteria but also contributes to the development of vegetable oil and feed production for agriculture. Under Uzbekistan's conditions, soybeans are becoming an essential component for the sustainable development of the agricultural sector and strengthening the country’s export potential [8].

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Soybean (*Glycine max*), sesame (*Sesamum indicum*), and flax (*Linum usitatissimum*) are valuable oilseed crops widely cultivated for their nutritional and industrial applications. Each of these plants contributes unique benefits: soybeans are rich in protein, sesame seeds are known for their high antioxidant content, and flax seeds are a major source of omega-3 fatty acids [6].

Systematics

Soybean (*Glycine max*) belongs to the Fabaceae family, one of the largest families of flowering plants. The genus *Glycine* includes more than 20 species, but only *Glycine max* is fully domesticated and widely cultivated. Its closest wild relative is *Glycine soja*, which is native to East Asia [2].

Botanical Description

Soybean is an annual herbaceous plant with a strong taproot system that can penetrate up to 2 meters deep. This makes it resistant to short-term droughts. The stem is upright, with a height ranging from 50 to 150 cm, depending on the variety and growing conditions. The stem can be branched or unbranched. The leaves are trifoliate, arranged on long petioles, and consist of three oval or egg-shaped leaflets. The flowers are small, white or purple, and gathered in racemose inflorescences. They are self-pollinating, ensuring high genetic stability of the plants. The fruit is a pod measuring 3 to 7 cm in length, containing 2–4 oval or round seeds. The seeds vary in color (yellow, green, black, or brown) and weight (1000 seeds weigh between 150 and 250 g).

Biological Features

Soybean (*Glycine max*) holds a prominent place among agricultural crops due to its unique properties and versatile applications. Its high content of proteins, oils, vitamins, and minerals makes it valuable in the food, feed, medical, and industrial sectors. Additionally, its biological features, such as symbiosis with nitrogen-fixing bacteria and high adaptability to various climatic conditions, contribute to its role in sustainable agriculture.

Global soybean production continues to grow, making an increasing contribution to food security and livestock development. At the same time, soybean cultivation in Uzbekistan is becoming strategically important for the country. Thanks to its ability to enrich soil with nitrogen, soybean improves soil fertility and enhances crop rotation efficiency. The expansion of sown areas and the adoption of advanced technologies enable Uzbekistan to meet its domestic demand for vegetable oils and high-protein feed while boosting its export potential.

Modern soybean breeding focuses on developing varieties resistant to biotic and abiotic stresses, as well as improving seed quality. The use of genomic technologies opens new horizons for increasing crop productivity and adapting it to changing climatic conditions. In Uzbekistan, special attention is given to creating varieties adapted to hot climates and irrigated conditions, which contributes to higher yields and drought resistance.

Importance

Soybean (*Glycine max*) has a wide range of applications in various industries, including food production, medicine, agriculture, and industrial manufacturing. Its significance lies in the unique composition of its seeds, which contain up to 40% protein, around 20% oil, as well as a rich array of amino acids, vitamins, and minerals.

Soybean plays a crucial role in different sectors due to its versatility and rich chemical composition. In the food industry, soy is widely used for the production of vegetable oil, which is highly valued for its content of polyunsaturated fatty acids and vitamin E. This oil is utilized

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in cooking, confectionery, margarine, and mayonnaise production. Additionally, it serves as a raw material for biodiesel production, highlighting its environmental value [1]. Soy products such as soybean meal and flour are valuable protein sources used in cooking and animal feed. Soy milk, tofu, and soy protein isolate are essential products for vegetarian and vegan diets, as well as for sports nutrition.

Soybean also holds significant medical importance. Its components, such as isoflavones, possess antioxidant properties, help reduce cholesterol levels, strengthen bone tissue, and lower the risk of cardiovascular diseases and some types of cancer [4; 5].

In agriculture, soybean meal is an indispensable component of feed for livestock and poultry due to its high protein content. Soy also plays a vital role in improving soil structure and fertility. Through symbiosis with nitrogen-fixing bacteria, it enriches the soil with nitrogen, reducing the need for mineral fertilizers [3].

The industrial uses of soybeans span areas such as biodiesel production, plastics, varnishes, paints, and detergents, underscoring the crop's importance in sustainable development and energy independence.

In Uzbekistan, soybean has become an important strategic crop. It supports the production of vegetable oils, reducing dependency on imports, and is also used to produce soybean meal, which serves as a foundation for animal feed in livestock farming. In 2022, soybean was grown on 80.4 thousand hectares of land, yielding 165 thousand tons of grain. This contributed not only to strengthening food security but also to enhancing the country's export potential [8].

Thus, soybean combines significance for food security, ecology, and industrial production, making it an indispensable crop both globally and in Uzbekistan.

Cultivation and Breeding of Soybeans

Soybean (*Glycine max*) is a versatile crop that thrives in various climatic conditions due to its biological characteristics. Its cultivation requires adherence to specific agronomic practices to achieve high yields.

Optimal conditions include a moderately warm climate with temperatures ranging from 20–30 °C. For full maturity, soybeans require a sum of effective temperatures between 1500 and 2000 °C. The crop grows best in loose, fertile soils with a neutral pH and does not tolerate saline or waterlogged soils. Irrigation is especially crucial during the flowering and pod formation stages. Soybeans are well-suited for crop rotation as they enrich the soil with nitrogen through symbiosis with rhizobium bacteria.

Cultivation practices involve sowing with row spacing of 45–70 cm to a depth of 3–5 cm, with a seeding rate of 80–100 kg/ha, along with regular crop maintenance. This includes inter-row cultivation, weed control, and protection against pests and diseases. Treating seeds with rhizobium bacteria before sowing enhances nitrogen fixation, improving soil fertility.

The average yield of soybeans ranges from 2 to 4 tons per hectare, but under irrigated conditions in Uzbekistan, yields can reach up to 3.5 tons per hectare. Soybeans are becoming increasingly popular in the country due to their importance for livestock feed and the food industry.

Modern breeding efforts are focused on developing high-yielding varieties adapted to specific climatic conditions and resistant to drought, diseases, and pests. Genomic selection and biotechnological methods are used to create varieties with high protein and oil content. In

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Uzbekistan, varieties adapted to hot climates and irrigated conditions are being developed, significantly improving productivity.

In 2022, soybean cultivation in Uzbekistan covered 80.4 thousand hectares, meeting domestic demand for vegetable oils and animal feed while creating opportunities for export development. Thus, the cultivation and breeding of soybeans play a crucial role in the development of Uzbekistan's agriculture, strengthening food security, and enhancing economic resilience.

Modern methods of soybean cultivation and breeding ensure high productivity and resilience to adverse conditions. This makes soybeans an essential component of agricultural systems, capable of addressing the challenges of population growth and climate change. Similar to sesame and flax, soybeans play an important role in sustainable agriculture by enriching the soil with nutrients. While soybeans excel in nitrogen fixation through symbiosis with rhizobia, sesame and flax thrive in arid and less fertile soils, making them complementary in crop rotation systems [7].

Conclusion

Soybean (*Glycine max*) is one of the most important agricultural crops with universal value. Due to its high content of protein, oils, vitamins, and minerals, it is widely used in the food, feed, medical, and industrial sectors. The biological features of soybeans, such as their symbiosis with nitrogen-fixing bacteria, high drought resistance, and adaptability to various climatic conditions, make them an indispensable crop for sustainable agriculture.

The global importance of soybeans continues to grow in the context of increasing population and the rising demand for plant-based proteins. Modern cultivation approaches, including the use of adapted varieties, efficient irrigation, and fertilizers, ensure high yields and quality products. In Uzbekistan, soybeans hold a special place due to their ability to enrich the soil with nitrogen, improve crop rotation productivity, and meet local demands for vegetable oils and feed products. Government support and the introduction of advanced technologies contribute to the development of soybean production and the enhancement of export potential.

Soybean breeding, which incorporates genomic methods and biotechnologies, opens new opportunities for increasing yields, enhancing stress resistance, and improving seed quality. These efforts not only boost crop productivity but also address global climate change challenges, ensuring the sustainability of agricultural systems.

Thus, soybean is a strategically important crop that plays a key role in ensuring food security, developing livestock farming, and strengthening economic sustainability. Its versatility and ecological benefits make it an integral part of the modern agricultural sector, both globally and in Uzbekistan.

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