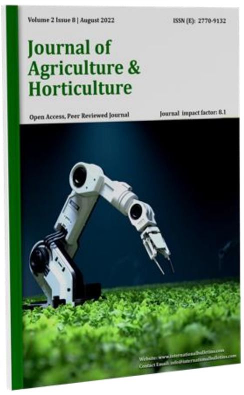

AGROBIOLOGICAL INDICATORS OF FOOD AND VEGETABLE SOYBEAN (GLYCINE MAX (L.) MERR.) UNDER THE CONDITIONS OF SAMARKAND REGION

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Abstract: This article presents the results of studying the agrobiological traits of food and vegetable soybean *(Glycine max (L.) Merr.)* under the conditions of the Samarkand region. The research was conducted during 2023–2025 and included an analysis of phenological stages, morphological traits, and yield components of soybean varieties. The results showed that food soybean varieties were characterized by a longer growing period and higher yield indicators compared to vegetable soybean varieties. Correlation analysis revealed a strong positive relationship between the number of pods per plant and seed yield. The obtained findings can be used for selecting high-yielding soybean varieties adapted to the regional conditions.

Key words: soybean, agrobiological traits, phenological stages, number of pods, seed yield, Samarkand region.

Introduction.

Soybean (*Glycine max* (L.) Merr.) is considered one of the most important crops worldwide as a source of food, feed, and industrial raw materials. The high content of protein and oil in its seeds, along with its adaptability to diverse agroecological conditions, places soybean among the strategic crops in agriculture.

According to scientific sources, the agrobiological characteristics of soybean varieties are directly influenced by soil and climatic conditions, heat and moisture supply, as well as the proper application of agronomic practices [2; 1]. In particular, food-grade and vegetable soybean varieties differ in their morphological and physiological traits, which are reflected in their biological growth rate and yield formation. Studies reported in [2] indicate that plant height development, branching degree, and the number of pods in soybean varieties are closely associated with yield level.

International research has extensively examined the agrobiological traits of soybean varieties across different ecological zones. For instance, [4] emphasizes that the extension or shortening of the growing period under various climatic conditions significantly affects the formation of yield components. Moreover, studies conducted by [5] revealed a strong correlation between morphological traits of soybean varieties and seed productivity.

In Uzbekistan, research on soybean cultivation has also been expanding in recent years. Local studies have investigated growth stages, duration of the vegetation period, and yield components of soybean varieties, demonstrating that certain varieties are well adapted to the soil and climatic conditions of the republic. However, most studies have primarily focused on yield and seed quality, while comparative analyses of agrobiological traits of food-grade and vegetable soybean varieties have not been sufficiently addressed.

The Samarkand region is characterized by specific climatic and soil conditions. Although sufficient heat resources create favorable conditions for soybean growth, growth rate, morphological traits, and the formation of yield components may vary considerably among

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varieties. Therefore, studying the agrobiological characteristics of food-grade and vegetable soybean varieties specifically under the conditions of the Samarkand region is of significant scientific and practical relevance.

Materials and Methods.

The research was conducted during 2023–2025 under the conditions of the Samarkand region. Food-grade and vegetable soybean (*Glycine max* (L.) Merr.) varieties were selected as the objects of study, while their agrobiological characteristics constituted the subject of the research. All observations and measurements were carried out in field and laboratory conditions using generally accepted methodologies.

In the agrobiological assessment, key indicators characterizing soybean growth and development were determined. Plant height (cm) was measured in each variant using 10–15 randomly selected plants, and the arithmetic mean was calculated. The duration of the vegetation period (days) was determined as the time interval from emergence to full maturity. The onset of phenological stages (flowering, pod formation, and maturity) was recorded through visual observations.

To evaluate yield components, the number of pods per plant (units), the number of seeds per pod (units), and seed yield per plant (g) were determined using counting and weighing methods. These indicators served as the basis for assessing the productive potential of the soybean varieties.

Results.

Since the adaptability of varieties to local conditions, earliness, and the formation of yield components are primarily reflected in the duration of phenological stages and in morphological–yield traits, the results were systematically analyzed in two directions: (1) phenological stages and (2) agrobiological indicators. The data obtained were summarized for the period 2023–2025, and mean values along with their variability (± m) were calculated for each parameter.

In assessing the rate of biological development of soybean varieties and their degree of adaptation to local climatic conditions, the duration of phenological stages serves as a key diagnostic criterion. Therefore, the periods from emergence to flowering, from flowering to pod formation, from pod formation to full maturity, as well as the total length of the vegetation period were observed during 2023–2025, and three-year average values were calculated (see Table 1).

Table 1. Duration of phenological stages in food-grade and vegetable soybean varieties (average for 2023–2025, ± m)

Variety	Type	Emergence–flowering, days	Flowering–pod setting, days	Pod setting–maturity, days	Vegetation period, days
Toyopro	Food-grade	38 ± 2.0	24 ± 1.0	56 ± 3.0	118 ± 4.0
Fora	Food-grade	36 ± 1.0	23 ± 2.0	56 ± 2.0	116 ± 3.0
Ilkhom-6	Vegetable	34 ± 3.0	21 ± 1.0	54 ± 2.0	109 ± 2.0
Sulton-6	Vegetable	33 ± 2.0	20 ± 2.0	53 ± 1.0	107 ± 3.0

The data presented in Table 1 show that the duration of phenological stages differed markedly among the varieties.

In food-type soybean varieties, the period from emergence to flowering was recorded at about 36–38 days, which was longer than in vegetable-type soybean varieties (33–34 days). For example, in the Toyopro variety this stage lasted 38 ± 2.0 days, whereas in the Sulton-6 variety it was 33 ± 2.0 days, resulting in a difference of 5 days. This indicates that the vegetative development phase in food-type soybean varieties proceeds more fully.

The stage from flowering to pod formation lasted 23–24 days in food-type soybean varieties and 20–21 days in vegetable-type varieties, indicating a faster transition to the reproductive phase in vegetable soybeans. In particular, this stage was 23 ± 2.0 days in the Fora variety and 21 ± 1.0 days in the Ilkhom-6 variety, representing a difference of 2 days.

The stage from pod formation to full maturity was the longest phase in all varieties, varying between 53 and 56 days. In food-type soybean varieties, this stage lasted around 56 days (Toyopro: 56 ± 3.0 days; Fora: 56 ± 2.0 days), whereas in vegetable-type soybean varieties it was slightly shorter (Ilkhom-6: 54 ± 2.0 days; Sulton-6: 53 ± 1.0 days). As a result, the total vegetation period amounted to 116–118 days in food-type soybean varieties and 107–109 days in vegetable-type varieties. For instance, the vegetation period was 118 ± 4.0 days in the Toyopro variety and 107 ± 3.0 days in the Sulton-6 variety, with a difference of 11 days. Thus, while vegetable soybean varieties are characterized by earliness, food-type soybean varieties have a longer vegetation period, providing greater time reserves for the full formation of yield components, which is scientifically substantiated.

Alongside phenological stages, morphological traits and yield components play a decisive role in evaluating the productivity potential of soybean varieties. Therefore, plant height, number of pods per plant, 1000-seed weight, and seed yield per plant were determined for the period 2023–2025, and a comparative analysis across varieties was conducted based on three-year average values (± m) (see Table 2).

Table 2. Agrobiological characteristics of food-grade and vegetable soybean varieties (average for 2023–2025, ± m)

Variety	**Type**	**Plant height, cm**	**Number of pods per plant, pcs**	**1000-seed weight, g**	**Seed yield per plant, g**
Toyopro	Food-grade	92 ± 5.0	43 ± 3.0	165 ± 6.0	19 ± 2.0
Fora	Food-grade	89 ± 3.0	40 ± 4.0	161 ± 5.0	17 ± 3.0
Ilkhom-6	Vegetable	79 ± 4.0	33 ± 2.0	149 ± 4.0	14 ± 1.0
Sulton-6	Vegetable	77 ± 2.0	32 ± 3.0	146 ± 3.0	14 ± 2.0

The results presented in Table 2 confirm the presence of stable differences among the varieties in terms of morphological and productivity traits. Regarding plant height, food-type soybean varieties exhibited higher values: 92 ± 5.0 cm in the Toyopro variety and 89 ± 3.0 cm in the Fora variety. In contrast, vegetable-type soybean varieties showed lower plant height, amounting to 79 ± 4.0 cm in Ilkhom-6 and 77 ± 2.0 cm in Sulton-6. Thus, the plant height of the Toyopro variety exceeded that of Sulton-6 by 15 cm, indicating a greater potential for vegetative organ development in food-type soybean varieties.

The number of pods per plant is recognized as a key component of yield formation. Food-type soybean varieties had a higher number of pods, with 43 ± 3.0 pods in Toyopro and 40 ± 4.0 pods in Fora. In vegetable-type soybean varieties, this indicator was around 32–33 pods

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(Ilkhom-6: 33 ± 2.0; Sulton-6: 32 ± 3.0), which is 7–11 pods fewer than in food-type varieties. This difference represents one of the main reasons for the variation in productivity indicators.

In terms of 1000-seed weight, food-type soybean varieties again showed superiority: 165 ± 6.0 g in Toyopro and 161 ± 5.0 g in Fora. In vegetable-type soybean varieties, this parameter was lower, amounting to 149 ± 4.0 g in Ilkhom-6 and 146 ± 3.0 g in Sulton-6. This indicates that food-type soybean varieties are characterized by larger seed size and greater mass stability, which in turn implies the formation of technologically more suitable raw material for processing.

Seed yield per plant also fully confirmed the general pattern: 19 ± 2.0 g in Toyopro and 17 ± 3.0 g in Fora, whereas in vegetable-type soybean varieties it ranged from 14 ± 1.0 to 2.0 g. For example, the seed yield per plant in the Toyopro variety was approximately 5 g higher than in Sulton-6, which can be explained by the higher number of pods and greater 1000-seed weight. Thus, under the conditions of Samarkand region, food-type soybean varieties demonstrated relatively more stable and higher morphological and productivity indicators, while vegetable-type soybean varieties were distinguished by their earliness, which is scientifically substantiated.

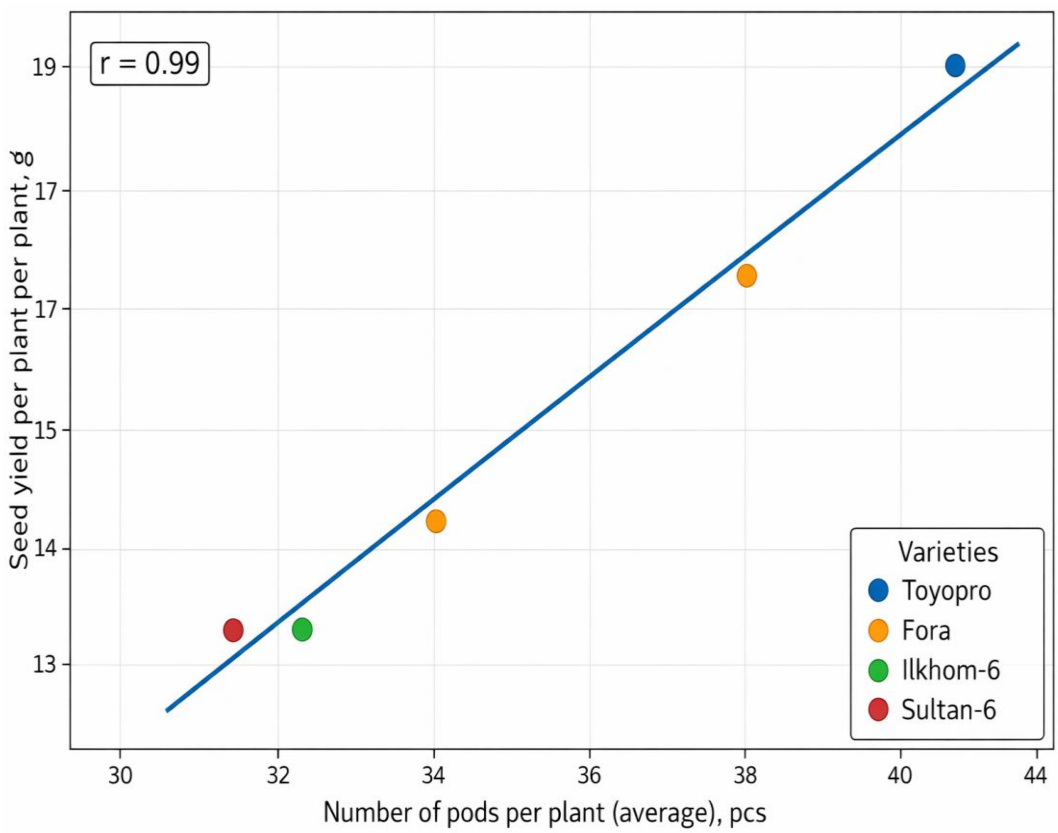

Figure 1. Correlation between the number of pods per plant and seed yield (2023–2025)

The results of the correlation analysis indicate a very strong positive relationship between the number of pods per plant and the seed yield obtained from a single plant. According to the graphical data, the correlation coefficient between these indicators was **r = 0.98**, confirming that seed yield increases proportionally as the number of pods increases. This demonstrates that the number of pods is one of the main biological factors determining yield formation in soybean.

In the graph, each variety is represented as a separate point. Food-type soybean varieties are characterized by higher values of both pod number and seed yield. In particular, the

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Toyopro variety had 43 pods per plant with a seed yield of 19 g, while the **Fora** variety had about 40 pods and a seed yield of approximately 17 g. In vegetable-type soybean varieties, these indicators were lower: the **Ilkhom-6** variety had 33 pods corresponding to a seed yield of 14 g, and the **Sulton-6** variety had 32 pods with a seed yield of 14 g.

The positive slope of the regression line clearly demonstrates a stable increasing trend in seed yield as the number of pods increases. This trend provides scientific justification for using pod number as a key diagnostic indicator in the agrobiological evaluation of soybean varieties and in their selection for breeding and production purposes.

Conclusions

1.Studies conducted under the conditions of Samarkand region showed that the vegetation period of food-type soybean varieties is longer than that of vegetable-type soybean varieties. Specifically, the total vegetation period was **116–118 days** for food-type varieties and **107–109 days** for vegetable-type varieties, with a difference of approximately **9–11 days**. This indicates that food-type soybean varieties have more time for complete formation of yield components.

2.Analysis of agrobiological traits confirmed the higher productivity of food-type soybean varieties. The number of pods per plant was **40–43** in food-type varieties and **32–33** in vegetable-type varieties, with a difference of **7–11 pods**. The 1000-seed weight was also higher in food-type varieties (**161–165 g**) compared to vegetable-type varieties (**146–149 g**).

3.Seed yield per plant was **17–19 g** in food-type soybean varieties and about **14 g** in vegetable-type varieties. For example, the seed yield of the Toyopro variety was approximately **5 g higher** than that of Sulton-6, which is explained by the higher number of pods (by 11 pods) and greater 1000-seed weight (by 19 g).

4.Correlation analysis revealed a very strong positive relationship between the number of pods per plant and seed yield (**r = 0.98**). When the number of pods increased from **32–33** to **40–43**, seed yield increased from **14 g** to **17–19 g**. This confirms that pod number is a key diagnostic indicator determining yield formation in soybean

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