BOTANY

PRODUCTIVITY OF SOYA VARIETIES IN THE FOREST-STEPPE OF UKRAINE

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Abstract

The article investigates the productivity of soybean varieties in the forest-steppe of Ukraine, in particular, the biological yield, chemical composition of grain and adaptive properties of different varieties. The research has shown that the Sigalia variety demonstrated the highest yield, which indicates its potential for production, as well as high protein and fat content, which makes it attractive for the food industry. Other varieties such as Diona, Diamond and Medea also performed well, but at slightly lower levels. The study highlights the importance of selecting varieties that can provide high productivity and quality, which will contribute to improved food security and economic sustainability of the agricultural sector. The results may be useful for agronomists and agricultural professionals.

Keywords: soybeans, varieties, yields, grain quality.

Introduction. Under the conditions of modern agricultural production in Ukraine, there is a growing demand for high-yielding soybean varieties, especially for cultivation in the Forest-Steppe zone, which is one of the main regions of soybean cultivation. Soybeans (*Glycine max* (L.) Merr.) are important as a source of protein and oil, which ensures their key role in food security and livestock production. The high protein content of soybeans makes them a promising crop for increasing feed supply, which is especially important given the environmental and economic challenges [1].

Breeding new soybean varieties adapted to the specific climatic conditions of the Forest-Steppe is an urgent task for agricultural science, as soybean productivity is highly dependent on weather conditions and agronomic practices. Climate change and temperature fluctuations pose additional challenges for agronomists, necessitating the search for stress-resistant soybean varieties. The forest-steppe of Ukraine has its own agro-climatic features that affect the vegetation of plants, including the length of the growing season, moisture availability and the level of stress [2, 3].

An important aspect of research into the productivity of varieties is their resistance to drought, pests and diseases, as well as their ability to achieve stable yields under changing climatic conditions. Today, Ukraine has a wide range of soybean varieties that differ in both biological characteristics and adaptive potential. However, the issue of selecting the best varieties for specific zones remains open.

The research is aimed at identifying soybean varieties that have the highest productivity and the best adaptability to the conditions of the Forest-Steppe of Ukraine. Agronomic evaluation of varieties is important to identify their optimal yield and resistance to external factors. The study includes an analysis of the response of different varieties to variable agro-climatic conditions, the level of technological support and the impact of biological products and fertilisers [4, 5].

The results of this research can serve as a basis for further improvement of soybean cultivation technologies and selection of varieties that ensure maximum productivity in the Ukrainian Forest-Steppe. This is especially important for the development of organic farming, as it allows to improve the quality and quantity of products without the use of synthetic inputs.

Material and Methods. Experiments to study soybean yields began in 2023 in the conditions of Zlagoda Farm, Bila Tserkva district, Kyiv region, and Stas Farm, Kozyatyn district, Vinnytsia region, through a comprehensive study. Laboratory studies were carried out at the Department of Plant Production Technologies and the certified laboratory of Polissia University.

From May to August 2023–2024, the Khmelnytskyi region experienced various weather conditions that affected agronomic indicators. In May 2023, the average temperature was around +16 °C, with precipitation of 60–70 mm, which was in line with seasonal norms. June was warm, with an average temperature of

+19 °C and higher precipitation of 85 mm, which created favourable conditions for crop growth. In July, the temperature rose to +22 °C, and although it reached +30 °C in some places, precipitation was 70 mm, which was slightly below normal. August 2023 ended the season with an average temperature of +21 °C and 65 mm of precipitation, accompanied by short-term showers, while maintaining sufficient soil moisture.

In 2024, May saw slightly warmer weather, with average temperatures around +17 °C, but precipitation dropping to 55 mm, causing a moderate moisture deficit. June remained warm, with an average temperature of +20 °C and precipitation of 90 mm, which provided the necessary moisture for active plant growth. July 2024 was one of the warmest on record, with an average temperature of +23 °C, at times exceeding +30 °C, and precipitation of 75 mm, which was in line with the norm. August 2024 had an average temperature of +22 °C and 60 mm of precipitation, creating optimal conditions for crop ripening.

In general, in these two years, weather conditions were favourable for agriculture, although 2024 was characterised by slightly higher temperatures and uneven precipitation, which could affect the moisture supply of crops at different stages of their development.

We studied varieties: Diamond, Dione, Medea, Sigalia. The arrangement of the experimental plots was systematic, replicated four times. The accounting area was 50 m^2.

The predecessor was hybrid winter rye. Ploughing was carried out after 3 weeks on the winter rye, with a depth of 22–24 cm. Before sowing – cultivation by 4–5 cm. The sowing method was line sowing (15 cm). The norm is 450 thousand germinating seeds per hectare. Rolling after sowing to preserve moisture. In the phase of 1–3 trifoliate leaves of soybeans, the crop was treated with a tank mixture of Bazagran herbicide, 0.7 l/ha, and Karate Zeon insecticide, 0.6 l/ha.

The grain harvest on the plots was harvested after removing it from the protective strips. The accounting part of each plot was harvested by a combine harvester, placed in bags and weighed.

Statistical data processing was carried out using Micrisoft Office Excel 2015 and Statistica software.

Results. Research results show that soybean yields are influenced by complex factors, including agronomic practices, varietal characteristics, climatic conditions and nutrition. An important factor is the choice of a variety that must be adapted to local conditions to realise its genetic potential. Among agronomic practices, special attention is paid to seeding rates and row spacing, which ensure optimal plant density. The use of biological and chemical plant protection products also plays a significant role in controlling weeds and pests. Research shows a significant dependence of yields on weather conditions, such as rainfall and temperature during critical phases of soybean growth.

One of the main features that characterises the economic value of soybean varieties is grain yield, which depends on the elements of productivity. Thus, the elements of the yield structure to a certain extent reflect the value of soybean yield (Table 1).

Table 1.

Formation of the yield structure of the studied soybean varieties, 2023–2024

Varieties	The height of the plant, cm	Lower bean attachment height, cm	Number of plants per $1m^2$
Medea	70–94	15	40,8
Diona	80–102	15	41,7
Diamond	70–92	16	42,5
Sigalia	70–82	16	43,4

Table 1 presents the characteristics of four soybean varieties – Medea, Diona, Diamond and Sigalia – with the main parameters that affect their productivity and adaptive properties. Plant height: among the varieties, Diona has the highest height (80–102 cm), which may indicate a greater potential for yield formation under optimal conditions. Plant height of other varieties varies from 70 to 94 cm. Lower bean attachment height: This is important for mechanised harvesting as lower beans may be left unharvested. Medea and Diona have a lower bean attachment height of 15 cm, and Diamond and Sigala have a lower bean attachment height of 16 cm, which is sufficient for more efficient harvesting.

Number of plants per m^2: plant density also affects yields. The Sigalia variety has the highest number of plants per m^2 (43.4), which can provide higher productivity under favourable conditions. The other varieties have between 40.8 and 42.5 plants per m^2, which is also optimal for achieving high yields.

In general, these indicators help to determine the potential of each variety for use in different agro-climatic conditions and cultivation technologies (Table 2).

Table 2

Quantitative indicators of the harvest, 2023–2024

Varieties	Number of beans per plant, pcs.	Number of seeds per bean, pcs.	Number of seeds per plant, pcs.	Weight of 1000 seeds, g
Medea	20,5	2,2	44,6	126
Diona	22,3	2,1	55,3	134
Diamond	23,6	2,7	61,2	171
Sigalia	21,0	2,6	57,0	158

Table 2 shows the productivity data of four soybean varieties – Medea, Dion, Sigalia and Diamond. They include the number of beans per plant, the number of seeds per bean, the total number of seeds per plant, and the weight of 1000 seeds.

Among the four varieties, Sigalia demonstrates the highest productivity indicators, in particular, the number of beans per plant is 23.6 and the average number of seeds per bean is 2.7, which is the highest among the varieties presented. This ensures the maximum total number of seeds per plant – 61.2 pcs, and the weight of 1000 seeds is 171 g, which indicates good filling and weight of seeds.

The Diamond variety also has high productive characteristics, including 21 beans per plant and an average number of seeds per bean of 2.6. The total number of seeds per plant reaches 57.0, and the weight of 1000 seeds is 158 g, which is slightly lower than Sigalia, but still quite high.

The Diona variety is distinguished by its average performance: about 22.3 beans are formed per plant, with an average of 2.1 seeds per bean, which ensures a total number of seeds of 55.3 pcs. At the same time, the weight of 1000 seeds is 134 g, which is slightly less compared to Sigilia and Diamond.

Finally, the Medea variety has the lowest performance: the number of beans per plant is 20.5, the number of seeds per bean is 2.2, and the total number of seeds per plant is 44.6. The weight of 1000 seeds is 126 g, which indicates a lower productivity of this variety compared to others.

Thus, analysing the indicators, we can conclude that Sigalia and Diamond are the most productive varieties due to the higher number of seeds and higher weight of 1000 seeds, which gives them an advantage in potential yield.

To evaluate the performance of different soybean varieties, we conducted a yield analysis that reflects the differences between varieties in terms of quantitative indicators. The table below shows the results for each variety, allowing us to compare their yield potential. The data includes the average yield depending on the varietal characteristics, which takes into account the adaptive properties of each variety to the growing conditions. This allows us to draw conclusions about the most productive varieties for further introduction into agricultural production (Figure 3).

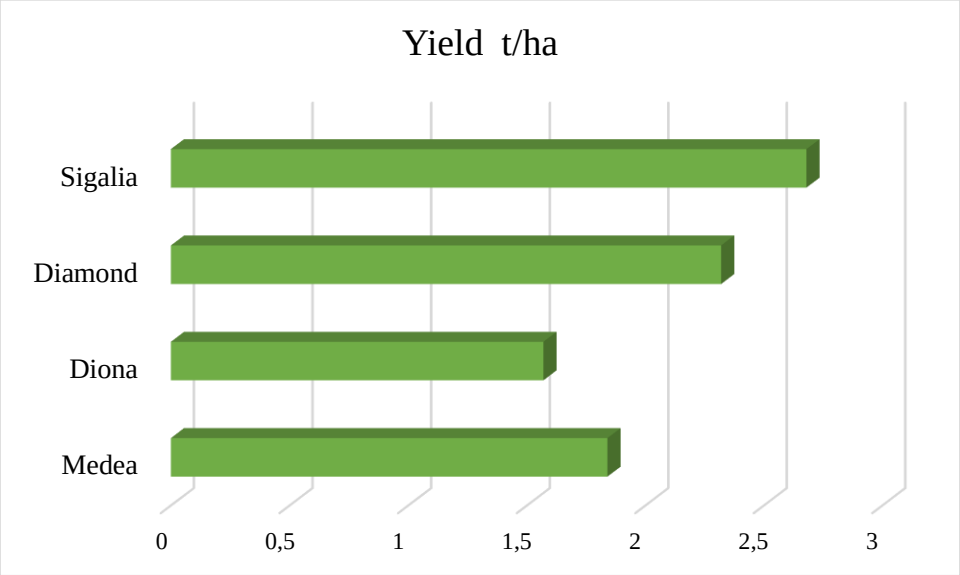
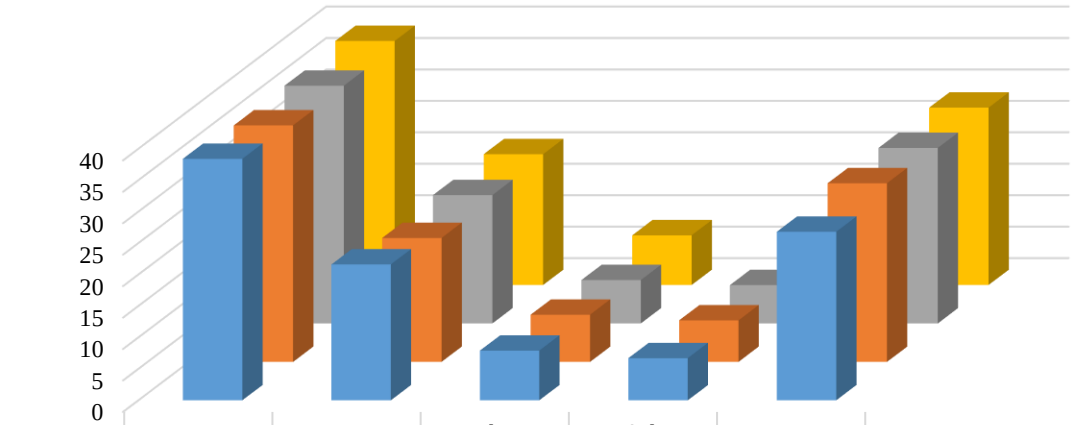


Figure 3. Grain yield of soybean varieties under study, 2023-2024

Figure 3 shows the yields of four soybean varieties: Dione, Medea, Diamond and Sigalia. Among them, Sigalia showed the highest yield of 2.68 t/ha, which indicates the high potential of this variety to produce a significant yield under favourable conditions. The second highest yielding variety was Diamond, with 2.32 t/ha, which also makes it a productive choice.

The Diona and Medea varieties demonstrated lower biological yields of 1.84 and 1.57 t/ha, respectively. This indicates their relatively lower potential, which may be due to their varietal characteristics or adaptability to growing conditions. Thus, in order to achieve maximum productivity among the studied varieties, it is recommended to grow Sigalia and Diamond varieties, which show higher yield results.

In 2023–2024, studies of the chemical composition of soybean varieties revealed important characteristics that affect their food and technological use. The analysis showed a variety of protein, fat and carbohydrate content, which makes these varieties valuable for feed and food production (Table 4).



	Protein	Fat	Fibre	Ash	BER
Medea	38,4	21,6	7,9	6,7	26,8
Diona	37,6	19,7	7,5	6,6	28,4
Diamond	37,8	20,4	6,9	6,1	27,9
Sigalia	38,8	20,8	7,9	6,2	28,2

Figure 4. Chemical composition of grain of soybean varieties, 2023-20234

The figure 4 shows the chemical composition of the grain of four soybean varieties - Dione, Medea, Diamond and Sigalia – with a focus on protein, fat, fibre, ash and energy balance (EB).

Sigaliya has the highest protein content of 38.8 %, which indicates its potential as a nutritious component in animal and human diets. Compared to other varieties, Diona also has a high protein content (38.4 %), which makes it attractive to agronomists and processors.

Medea shows a protein content of 37.6 %, and Diamond – 37.8 %, which indicates sufficient nutritional value, but lower compared to Sigila.

Fat content ranges from 19.7 % for Medea to 21.6 % for Diona, with Sigia and Diamond averaging 20.8 % and 20.4 % respectively. Fibre, which is important for digestion, is highest in Diona and Sigalia (7.9 %), while Diamond has a 6.9 % content.

The varieties also differ in terms of ash content: Diamond has the lowest content (6.1 %), while the other variants range from 6.2 % to 6.7 %.

In general, the analysis of the chemical composition of the grain shows that Sigalia and Diona have the highest protein and fibre values, making them the most nutritious varieties, while the others, although having good characteristics, show slightly lower values. These results are important for the selection of soybean varieties that can meet the requirements of modern agronomic production.

Conclusion. As a result of the research, it was found that the productivity of soybean varieties varies significantly depending on their biological characteristics and chemical composition. The Sigalia variety was the most productive, demonstrating the highest yield (2.68 t/ha), which indicates its prospects for cultivation in the forest-steppe of Ukraine. The high protein and fat content in the grain of this variety makes it particularly valuable for the feed industry and nutrition.

Thus, the results of this study can be useful for agronomists seeking to optimise soybean production, ensuring a high-quality harvest and increasing the efficiency of agricultural production in Ukraine. It is recommended to introduce the most productive varieties into practice, which will improve food security and economic sustainability of the agricultural sector.

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