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SELECTION OF ADAPTIVE SOYBEAN VARIETIES IN CULTIVATION TECHNOLOGY UNDER CONDITIONS OF CLIMATE CHANGE

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Due to global and rapid changes in climatic conditions for the cultivation of major crops, there is an urgent need for the selection of adaptive varieties that will not reduce their productivity. In modern agricultural production, the variety is the biological foundation on which all elements of cultivation technology are based. If you choose the right variety, it will enhance the effect of other factors. Conversely, if the manufacturer makes a mistake with the chosen variety, it will weaken the effect of all other factors.

In agricultural production, it is difficult to predict the outcome, because the existing approaches to soybean cultivation are 70% dependent on soil and climatic conditions. To solve this problem, you need to carefully select adaptive varieties of soybeans.

In Ukraine, a fairly large range of soybeans of different maturity groups. In conditions of intensive agriculture with extreme weather conditions, it is important to grow several varieties of different maturity groups on farms.

The article highlights the results of the analysis of the State Register of plant varieties suitable for distribution in Ukraine [1], as well as analysis of research by other scientists on the basis of which we chose two adaptive varieties of different maturity groups with genetic potential of 4-5 t / ha Ukrainian and foreign selection: Ukrainian (early-ripening variety Nugget) and Canadian selection (early-ripening variety Amadeus). These varieties are adapted for growing in the Forest-Steppe zone, have high resistance to lodging and shedding. Resistant to soil moisture deficiency, high temperatures and drought-resistant in summer, which is relevant in climate change. The height of attachment of the lower beans in the nuggets Nuggets and Amadeus 13 cm, which determines its suitability for full mechanized cultivation from sowing to harvesting.

Phenological observations of seedlings of the studied varieties according to the scheme: Factor A - variety: Nugget, Amadeus. Factor B - inoculation. Factor B - foliar feeding. The experiment was laid on the experimental site of 0.06 ha. The seeds were treated with BTU-t Bioinoculant at the rate of 3 kg / t of seeds, the control was not processed. After the mass emergence of seedlings, it was found that the seeds treated with bioinoculants came out a little later than the control, because bacteria slow down the germination of seeds.

Key words: *soybean, variety, productivity, legumes, stability, adaptability, climate change, inoculation.*

Table 3. Fig. 1. Lit. 19.

Formulation of the problem. In recent years, the problem of grain producers in choosing varieties for their farms has become especially relevant, when foreign companies import high-yielding, but often unadapted to the changing weather conditions of Ukraine Western European varieties [2].

Therefore, the aim of our study was to analyze the adaptive soybean varieties of domestic and foreign producers included in the State Register of Plant Varieties of Ukraine suitable for distribution in 2022 [1], based on their cultivation in climate

change; identify them by the level of yield in different natural and climatic conditions of Ukraine; choose adaptive soybean varieties for your research.

Analysis of recent research and publications. Legumes occupy an important place in the agro-industrial complex of Ukraine. This is due to the relatively cheap source of high-quality protein for human nutrition and balancing feed for farm animals and poultry. Recently, their role as important soil improvers has come to the fore. The positive role of soybean cultivation is that the crop is able to fix up to 100-150 kg of atmospheric nitrogen, which is equivalent to 15-20 tons of organic fertilizers. In this case, soybeans used in the growing season does not use all the nitrogen, what remains in the soil, gets to the next crop rotation. Nitrogen remaining after soybeans, unlike nitrogen from mineral fertilizers, is easily absorbed by subsequent plants and does not pollute the environment [3].

Proper selection of several varieties is one of the crucial conditions for obtaining the maximum yield in production. At the same time, this is one of the most accessible agricultural measures to reduce the negative impact of limiting environmental factors on the level of crop yields, which mostly provides plasticity to specific growing conditions. It should be noted the importance of selecting a variety that is resistant to stressors in modern climate change (increasing temperature, increasing drought, heat, etc.).

The main way to assess the plasticity is to analyze the yield of seed varieties for several years in a row, which will differ in soil and climatic conditions. The term "adaptability" means the ability to ensure high and sustainable productivity of plants under different conditions environment [2].

Created soybean varieties are often not in demand in agricultural production not because of reduced productivity potential, but because of their lack of environmental stability and adaptability to climate change, increasing drought during the growing season, as well as sharp temperature fluctuations [4,5,6].

According to Mazur O.V., Poltoretskyi S.P. [4,5], Polishchuk M.I. [6] and Monarkh V.V. [7] Soybeans are considered a sufficiently plastic crop to contrast growing conditions, but have increased requirements for heat and moisture. The need for heat can depend on many environmental factors. Temperature requirements increase from seed germination to germination phase, and decrease slightly, from the flowering phase to the seed formation phase, as well as at the time of seed maturation [4-7]. But choosing the right variety is not 100% success

Studies by scientists Zabarna T.A. and Pelekh L.V. indicate that foliar fertilization with negligent microfertilizers have a positive effect in certain phases of the growing season of soybean plants, especially when plants are deficient in nutrients [8-9].

The task of our research was to analyze the adaptive varieties, to choose those that in combination with the right elements of cultivation technology will give the best results in terms of yield and grain quality.

Conditions and methods of research. The field experiment was established in

May 2022 on the basis of NDG «Agronomiche» of Vinnytsia National Agrarian University, the village of Agronomichne on gray forest medium-loam soils. Two soybean varieties of different maturity groups of Ukrainian and foreign selection were selected based on the analysis of the State Register of Plant Varieties Suitable for Distribution in Ukraine in 2022 [1]: Ukrainian (early-maturing Samorodok variety) and Canadian selection (early-maturing Amadeus variety). The seeding rate was 500 and 600 thousand pieces per 1 ha with a row spacing of 45 cm. Sowing was carried out with a hand drill. The total area of the research site is 600 m^2. Repeat the experiment three times.

Regarding the climate, the average day and night temperatures during May are 17,5 °C and 9,2 °C, respectively. Sunny days are observed most of May, but cloudy and gloomy days are not uncommon. In May there were 9 rainy days with precipitation of 1-2 mm.

The research was conducted according to methodological recommendations. To reliably assess the emergence of seedlings conducted phenological observations in accordance with the "Methods of State Variety Testing of Crops". Phenological phases of plants were noted. The beginning of the phase was noted when it occurred in 10% of soybean plants, the complete phase in 75% of soybean plants in four versions of our studies [10,11,12].

Presentation of the main research material. At the beginning of the 21st century, soybeans were not yet considered the main crop, they were grown in small areas of several tens of thousands of hectares. In the period from 2008 to 2015, a rapid annual increase in sown areas began. Currently, the process has more or less stabilized. Now fluctuations in the number of sown areas under soybeans occur depending on the market situation and climatic conditions [13].

Ukraine ranks 9th in the world, with a sown area of 1.550 million hectares, or 1% of the world's data. The same market share is occupied by countries: Bolivia, Nigeria, Uruguay, the EU and South Africa [13,14]. Comparative data are shown in table 1.

Table 1.

World countries are leaders in soybean production.

Country	Production, million tons
Brazil	124
USA	96,8
Argentina	51
China	18
Paraguay	10
India	9,3
Canada	6
Russia	4,3
Ukraine	3,7
Bolivia	2,9

Source: formed by the author on the basis of [13, 14].

The climate in Ukraine has been changing rapidly over the last decade. In some parts of the country, the profitability of soybean production is declining sharply, so agribusiness is at risk. in others - and predictability. Existing technologies for growing legumes can not give the expected result, because they are 70% dependent on soil and climatic conditions in a particular region [13]. This has led to low yields over the past few years. To solve this problem, it is necessary to carefully select adaptive soybean varieties and look for new approaches to improving the elements of cultivation technology.

One of the important conditions in the formation of high productivity of soybeans is the variety. Currently, soybean variety resources are updated annually, 279 soybean varieties are included in the State Register of Plant Varieties Suitable for Distribution in Ukraine in 2022 [1], 110 of them are domestic and 169 foreign (71 Canadian varieties) [1].

Soybean varieties in the Register of Varieties are represented by a selection of 13 countries, the largest share are domestic varieties - 38% of the total number of soybean varieties, Canada - 25%, France - 15%, Austria - 6%, Serbia - 2%, Switzerland - 2% , Poland - 1% and 11% of other countries (Romania, Germany, Argentina, Italy, Croatia, Antigua) [1], are shown in Figure 1.

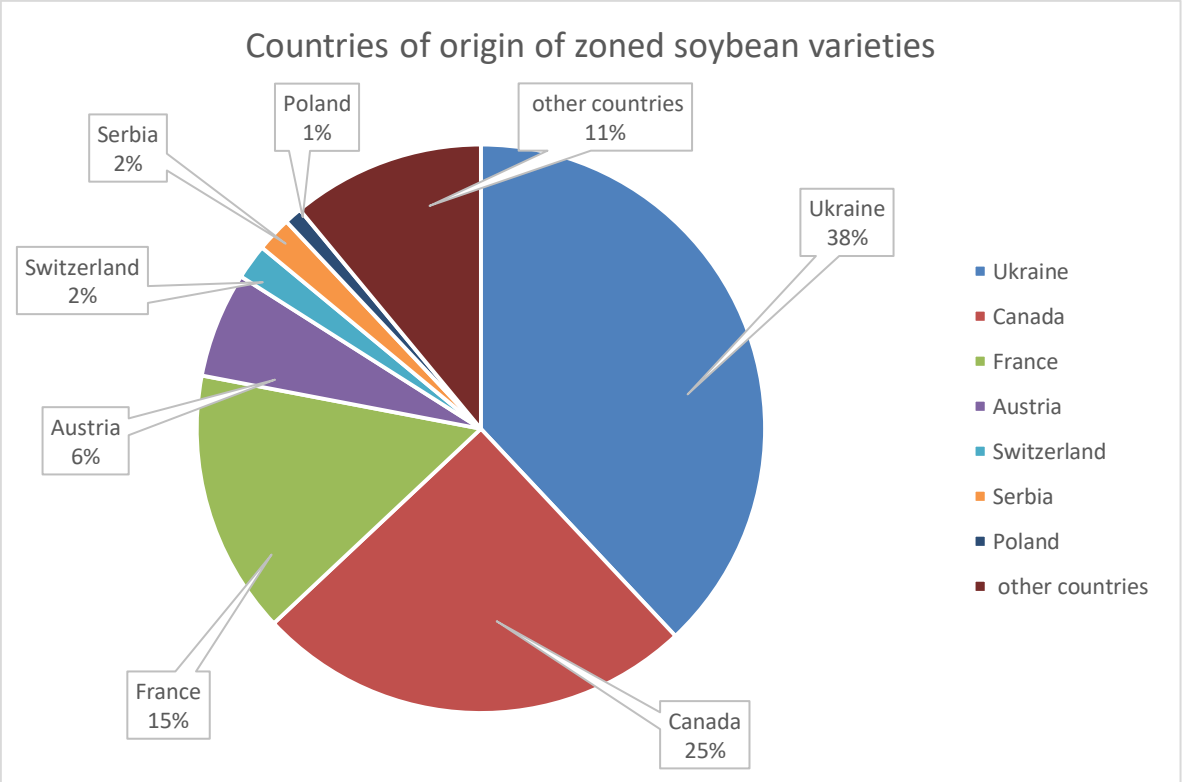

Figure 1. Cultural soybean varieties by origin, which are included in the State Register of Plant Varieties Suitable for Distribution in Ukraine as of January 17, 2022.

Source: formed by the author on the basis of [1]

These figures will be updated annually, so it is important to reveal the potential of new adaptive varieties with the involvement of biological products of different nature - stimulants, enhancers, nitrogen fixation and complexes of modern chelated microfertilizers. This will contribute to the development of new elements of soybean cultivation technology adapted to the conditions of the region, which will guarantee high and stable yields with high quality indicators. Also, research of this system will provide optimization of processes of growth, development and will serve formation of the maximum productivity of culture.

Under ecological plasticity is understood the ability of the variety to effectively use environmental factors. The stability and plasticity of adaptive soybean varieties are due to the ability of plants to minimize the effects of adverse effects of soil and climatic conditions, ie to resist them [2].

The use of high-tech, well-adapted to extreme environmental factors varieties is the basis for achieving high yields and quality of soybean seeds. The value of the variety for production is determined by both genetic potential and stability of its implementation. Varieties with a relatively high value of plasticity may be less productive for some time than varieties with less genetic potential, but with a more stable realization of productivity potential [2].

The growing season of soybean varieties is due to their genetic characteristics. However, both the general growing season, the interphase period of soybean varieties and yields depend on the influence of weather conditions of years of research, as well as technological factors which include the sowing period according to soil temperature and seeding rates. The early spring of recent years causes intense warming of the soil and promotes the sowing of all crops, including soybeans. The need for early sowing of soybeans is due to the fact that it does not lose moisture from the top layer of soil and get a friendly and full-fledged seedlings. However, under such conditions, the possible return of spring frosts and insufficient heat and light affect the duration of the period of sowing-seedlings, seedlings-first trifoliate leaf and budding [6]. That is why it is important to choose adaptive soybean varieties that will not be affected by climate change and this will allow you to get the maximum yield.

Ukraine has a rather large assortment of soybeans of different ripeness groups: ultra-early, early-ripening, medium-early-ripening, medium-ripening and medium-late-ripening. In conditions of intensive agriculture with extreme weather conditions, it is important to grow several varieties of different maturity groups on farms [15].

Soybean yield can be increased by 30-45% if you master the adaptive varietal technology of cultivation, upgrade, replace varieties. [16]. Global climate change, which has been observed in Ukraine in recent decades, requires new qualitative approaches to the creation of adaptive soybean varieties. In modern conditions, breeders in the first place put the level of adaptive potential of the variety, its ability to adapt to various changes in meteorological factors [17].

Ukraine has the largest variety of soybeans in Europe. This is due to the fruitful work of Ukrainian breeders. Varieties of Ukrainian selection in terms of yield and protein content are not inferior to foreign varieties and with a productivity level of 4-5 t / ha do not have genetically modified organisms. However, the realization of the genetic potential of modern varieties remains quite low, and the average yield in Ukraine is 0.9-1.4 t / ha. Realization of the genetic potential of the above varieties requires the development and application of modern cultivation technologies [17].

In the choice of variety the main evaluation criteria are: productivity, length of the growing season, resistance to shedding and lodging, disease and pest damage, resistance to temporary waterlogging and drought. Soybean varieties must make effective use of all vital factors throughout the growing season. The objective choice of a variety largely depends on the results of the regional ecological variety test. When choosing a variety, first of all it is necessary to pay attention to its zoning zone, because due to insufficient ecological plasticity of soybean variety, which formed high productivity in the steppe, in the Forest-Steppe may not guarantee the expected results [17].

We analyzed the State Register of Plant Varieties Suitable for Distribution in Ukraine as of January 17, 2022 [1], indicators of economic suitability of varieties (presented in Table 2), which were determined at the Ukrainian Institute of Expertise,

Table 2

Indicators of economic suitability
Samorodok and Amadeus varieties for the previous 5 years

Indicator	Value					
	Samorodok			Amadeus		
	S	F-S	P	S	F-S	P
Yield, c / ha	12,3	22,7	17,5	11,5	21,7	19,1
± to the average value of yield, c / ha	-4,6	0,7	-2,9	-8,3	-1,6	-3,6
± to the average value of yield,%	-27	3	-14	-42	-7	-16
Weight of 1000 seeds, g	138,8	149,4	149,2	139,4	161,9	176,7
Height of plants, see	66,1	73,9	78,5	70	73	77
Resistance to lodging, score	9	8	8	9	9	9
Resistance to shedding, score	8	8	9	8,9	8,9	9
Drought resistance, score	8	8	8	8,2	8,1	9
Height of attachment of the lower bean, see	11,3	13	15,6	12,7	12,4	10,8
Resistance to downy mildew, score	9	9	9	8,7	9	9
Resistance to ascochitosis, score	9	9	9	9	8,9	9
Resistance to bacteriosis, score	9	9	9	9	8,4	8,8
Resistance against septoria, score	9	9	9	9	9	9
Resistance to fusarium wilt, score	9	9	9	9	8,8	9
Protein content,%	41,3	41,0	41,7	45,9	45,7	45,1
Oil content,%	22,6	22,0	21,1	20,6	19	18
Direction of use	cereal	cereal	cereal	cereal	cereal	cereal

Source: formed by the author on the basis of [1,17-19].

and based on research by scientists such as Melnyk A. V., Romanko Yu.O. and decided to choose for research 2 soybean varieties of different maturity groups of Ukrainian and foreign selection [1,2,17-19]: Ukrainian (early-maturing variety Samorodok) and Canadian selection (early-maturing variety Amadeus).

According to the results of indicators of economic suitability of soybean plant varieties of the Ukrainian Institute of Expertise, the varieties Samorodok and Amadeus are recommended for cultivation in the Forest-Steppe zone.

The experiments were conducted on the basis of Research Farm «Agronomichne» Vinnytsia National Agrarian University, Agronomiche village on gray forest medium-loam soils. Sowing was carried out on May 4, 2022. Pre-sowing treatment of seeds was performed with Bioinoculant-BTU-t at the rate of 2-3 kg / t. Control was left untreated. The scheme of the experiment is as follows: Factor A - variety: Samorodok, Amadeus. Factor B - inoculation. Factor B - foliar feeding (table 3).

Table 3

Scheme of the experiment on the Samorodok and Amadeus

Varieties (factor A)	Seed treatment (factor B)	Foliar feeding (factor C)
Samorodok	Without processing (control)	Without feeding (control)
	Inoculation Bioinoculant-BTU-t (3 kg / t)	in phase 3 of the true leaves
	Inoculation Bioinoculant-BTU-t (3 kg / t)	in the flowering phase - budding
	Inoculation Bioinoculant-BTU-t (3 kg / t)	in phase 3 of the true leaves
		in the flowering phase - budding
Amadeus	Without processing (control)	Without feeding (control)
	Inoculation Bioinoculant-BTU-t (3 kg / t)	in phase 3 of the true leaves
	Inoculation Bioinoculant-BTU-t (3 kg / t)	in the flowering phase - budding
	Inoculation Bioinoculant-BTU-t (3 kg / t)	in phase 3 of the true leaves
		in the flowering phase - budding

Source: formed by the author on the basis of his own research

The beginning of the phase of seedlings of the Samorodok variety was noted in 13 days after sowing (control in 11 days), the beginning of the phase of seedlings of the variety Amadeus - in 16 days after sowing (control in 14 days).

It should be noted that the emergence of control seedlings of the variety Samorodok Samorodok and Amadeus was a few days earlier than in the case of seed treatment, because the activity of bacteria slows down the germination of seeds, as well as insufficient rainfall.

Conclusions and prospects for further research. From the above we can conclude that in modern agricultural production, the variety is the biological foundation on which all elements of cultivation technology are based. The right or wrong choice

enhances or, conversely, weakens the effect of all other factors. The introduction of new, high-yielding soybean varieties into production, the characteristics of which best meet the specific soil and climatic conditions of cultivation, is a reliable means of obtaining high yields of soybean seeds and the opportunity to increase its production [17].

Every year, soybean varietal resources are updated, as of January 17, 2022, 279 soybean cultivars were entered in the State Register of Plant Varieties suitable for distribution in Ukraine, of which 110 were domestic and 169 foreign [1]. We chose the variety Samorodok (Institute of Forage and Agriculture of Podillya of the National Academy of Agrarian Sciences of Ukraine) and Amadeus (Siemens Prograin INC). According to the results of economic suitability of soybean plant varieties of the Ukrainian Institute of Expertise, the selected varieties showed high productivity, resistance to shedding and lodging, disease and pest damage, resistance to temporary waterlogging and drought.

The quality of soybean varieties in Ukraine is gradually improving, breeders have recently achieved great success. Rapid climate change is observed in Ukraine, so the search for qualitatively new approaches to the development of new or improvement of existing cultivation technologies for adaptive soybean varieties of domestic and foreign selection is relevant in further research.

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АНОТАЦІЯ
ПІДБІР АДАПТИВНИХ СОРТІВ СОЇ У ТЕХНОЛОГІЇ ВИРОЩУВАННЯ ЗА УМОВ ЗМІНИ КЛІМАТУ

У зв'язку з глобальними та швидкими змінами кліматичних умов вирощування основних сільськогосподарських культур існує нагальна потреба пібдору адаптивних сортів, які не будуть знижувати свою продуктивність. У сучасному сільськогосподарському виробництві сорт є біологічним фундаментом, на якому базуються всі елементи технології вирощування. Якщо обрати правильний сорт, він підсилить дію інших факторів. І навпаки, якщо виробник помилиться з обраним сортом, він послабить дію всіх інших факторів.

У агровиробництві важко передбачити результат, тому що існуючі підходи до вирощування сої на 70% залежать від ґрунтово-кліматичних умов. Щоб вирішити цю проблему треба ретельно підбирати адаптивні сорти сої.

В Україні достатньо великий сортимент сої різних груп стиглості. В умовах інтенсивного землеробства з екстремальними погодними умовами важливо вирощувати у господарствах кілька сортів різних груп стиглості.

У статті висвітлюються результати аналізу Державного реєстру сортів рослин, придатних до поширення в Україні [1], а також аналіз результатів досліджень інших науковців на основі яких ми обрали два адаптивні сорти різних груп стиглості з генетичним потенціалом 4-5 т/га української та зарубіжної селекції: української (скоростиглий сорт Самородок) та канадської селекції (ранньостиглий сорт Амадеус). Ці сорти адаптовані до вирощування в зоні Лісостепу, мають високу стійкість до вилягання та осипання. Стійкі до дефіциту вологи у ґрунті, підвищеної температури та посухостійкі влітку, що актуально в умовах зміни клімату. Висота прикріплення нижніх бобів у сотрів Самородок і Амадеус 13 см, що визначає її придатність до повного механізованого вирощування від посіву до збирання.

Проведено фенологічні спосереження сходів досліджуваних сортів за схемою: Фактор А – сорт: Самородок, Амадеус. Фактор Б – інокуляція. Фактор В – позакореневі підживлення. Дослід закладали на дослідній ділянці 0,06 га. Насіння було оброблене Біоінокулянтом БТУ-т у нормі 3кг/т насіння, контроль не обробляли. Після масової появи сходів було встановлено, що оброблене біоінокулянтом насіння, сходило дещо пізніше від контролю, тому що бактерії сповільнюють проростання насіння.

Ключові слова: *соя, сорт, продуктивність, зернобобові, стійкість, адаптивність, зміна клімату, інокуляція.*

Табл. 3. Рис.1. Літ. 19.

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