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The results of study of ecological stability and plasticity of Ukrainian soybean varieties

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ABSTRACT

The article gives analysis of practical value of soybean varieties according to productivity and ecological plasticity in different climatic provinces of Ukraine. Ecological estimation of soybean varieties by the methodology of Eberhart and Rassel has been made. This estimation helped to determine variety plasticity and potential to adaptability. It has been established that varieties Almaz and Diona were the best according to the results of ecological research of varieties. The most favourable regions for cultivation of up-to-date soybean varieties have been chosen. Variety Almaz has been defined as the most intensive and plastic soybean variety (average yield during research years was 2.66–2.93 t/ha). Varieties Antratsit and Ametist also have shown high plasticity. The article gives rank estimation of practical value of soybean varieties on the basis of grain productivity.

It has been established that all examined varieties had high economic value – coefficient of agronomic stability is higher than 70%.

Variety Almaz has the greatest selective value according to homeostatic character. Almaz is the most intensive variety with maximal plasticity grown in Poltava region.

Varieties with high indices of adaptability and plasticity which are very valuable for selection and practical use have been singled out.

Introduction

Ecological plasticity and yield stability in different years and under different cultivation conditions are very important for variety description [1,2]. Variety plasticity is a quality of plants to form satisfactory yield being grown in different climatic conditions. Variety stability is an indicator of resistance in realization of selective and genetic genotype properties being grown in different conditions [3–5]. Plasticity and stability characterize homeostatic character of variety taking into account changes of cultivation conditions and ability to adapt [6].

These researches have been done by the methodology of Eberhart S.A., Rassel W. K. (1969). These scientists offered to estimate ecological plasticity of varieties according to two indicators such as coefficient of regression and mean square deviation from regression lines or stability variants which characterize in the first case their reaction in changed conditions of cultivation [5].

The higher numerical value of coefficient the more variety reaction on improving cultivation conditions. Thus, varieties with higher regression coefficient and lower mean square value have optimal indicators.

High sensitivity of some varieties to unfavorable cultivation conditions offen restricts the area of these varieties cultivation and limits their general distribution. On the basis of the results of examination of soybean varieties in different regions we can predict genetically defined degree of yield stability (adaptation to cultivation conditions).

Material and methods

Varieties of Ukrainian selection enrolled in the Register of plant varieties of Ukraine in different years and which occupy large sown areas in the country have been examined [8–10]. Ecological test of varieties Yug-30, Almaz, Diona, Anzhelika was done in 2005 year on the variety trial stations in six provinces (in accordance with climatic division into districts of soil and climatic zones) of Ukraine [11]. Each province is characterized by distinctive soil and climatic conditions that make it possible to carry out comprehensive ecological estimation of varieties. Ecological test of eleven soybean varieties was carried out during three years (2009–2011 years) in

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the conditions of Poltava region.

Phenological observations, data record and analysis have been made in accordance with methodology of state test of crops [12,13]. Method of Eberhart S. A. and Rassel W. A. was used for determination of stability parameters (agroecological estimation of soybean varieties) [7]. Mathematical processing of yield data was done by methods of dispersion, variation, correlated analysis and methods of estimation of considerable difference of average sampling by t-criterion [14]. Variety adaptation was determined on the basis of the results of ecological researches.

Research results

Interaction of yield of studied soybean varieties has been established taking into account diversity of weather conditions, duration of vegetation period and yield stability.

Ecological estimation of soybean varieties has been made according to following statistical indicators: average yield, dispersion and standard deviation from arithmetic mean, maximal, minimal value and amplitude of yield indicator, mistake of arithmetic mean, determination of homeostatic character and coefficient of variety agronomic stability.

The results of ecological study of soybean varieties in 2005 year are shown in Table 1.

The best varieties in comparison with average yield (2.47 t/ha) of the experiment were varieties Almaz and Diona (2.73 t/ha and 2.50 t/ha respectively). Variety Yug-30 (2.44 t/ha) was close to them.

Provinces Dnestrovsko-Dneprovskaya forest-steppe, Prichernomorskaya middle steppe and Donetsko-Donskaya north steppe are the most favourable for cultivation of the examined soybean varieties. Average increases in comparison with average yield in the experiment were 1.06 t/ha, 0,10 t/ha and 0.01 t/ha.

We can say about dependence of variety stability on influence of ecological conditions of the region on the basis of a number of statistical indicators. Thus, we can draw a conclusion about degree of variety stability under influence of different ecological conditions of the regions taking into account variation amplitude (difference between maximal and minimal yield). The lower this indicator the more stable variety. In compliance with this indicator varieties were differentiated in the order of decrease: Anzhelika, Yug-30, Diona and Almaz.

The mistake of arithmetic mean has been used for description of arithmetic mean at 5% value level ($x \pm t_{05}s_x$). The less number of mean fluctuations the more reliable result. Taking into account mistake of arithmetic mean soybean varieties have been placed in the order analogical to variation amplitude: Anzhelika, Yug-30, Diona and Almaz.

Ecological coefficient of variance characterizes the degree of arithmetic mean changeability (to 10% – low diversity, 10–20 – middle and >20 – high). Thus, all studied soybean varieties were included into the group with low degree of changebility to 10%.

Homeostatics characterizes selective value of variety genotype. The higher this indicator the greater possibility of involving this variety into following selective process. According to this indicator studied varieties have placed in the following order: variety Almaz was the most valuable, varieties Anzhelika, Yug-30 and Diona had identical value.

Coefficient of agronomic stability of the variety characterizes indicator of economic value of variety. Varieties with indicator higher than 70% will be optimal for cultivation. All examined soybean varieties correspond to this level. In the group they have placed in such order: Anzhelika, Almaz, Diona and Yug-30.

Estimation of specific variety value that is stipulated by both genetic variety potential (Ei) and stability of realization (Ri) allow to determine value of each of them and offer complex estimation of the level of grain yield, line of indicators of technological quality and disease resistance.

Calculation of specific significance of soybean varieties according to crop yield is given in Table 2.

Rank estimation of practical value of soybean varieties according to grain yield has been made too. The lower rank of the studied variety in comparison with zoned variety the higher economic value of this variety.

Most of the studied varieties (except variety Anzelika) belong to the second rank according to genotypical effect (yield indicator). According to plasticity they also belong to the second rank. Varieties Almaz, Diona and Yug 30 were the best by the sum of ranks.

According to mass of 1000 grain, grain humidity and duration of vegetation period varieties differed only by genotypical effect. Variety Anzhelika had rank 1, varieties Almaz and Diona had rank 2 and Yug- 30 had rank 3. All varieties belong to the second rank in compliance with plasticity. According to the sum of ranks varieties have placed in the same order.

It is necessary to admit that variety Almaz was the best according to resistance to lodging, fall, drought and also resistance to ascochyta-leaf spot and leaf blotch.

Ecological test of eleven varieties was carried out during three years in the conditions of Poltava region. The weather conditions of 2009–2011 years were not similar: 2009 year was characterized as

Table 1
Productivity of soybean varieties, t/ha
(the results of ecological study, 2005 year).

Provinces in Ukraine	Soybean varieties				Mean	Difference
	Yug-30	Almaz	Diona	Anzhelika		
Dnestrovsko-Dneprovskaya forest steppe	3.59	3.84	3.62	3.05	3.53	1.06
Prichernomorskaya middle steppe	2.56	3.02	2.84	1.85	2.57	0.10
Donetsko-Donskaya north steppe	2.38	2.82	2.3	2.41	2.48	0.01
Levoberezhno- Dneprovskaya forest steppe	1.77	2.18	2.03	1.87	1.96	−0.51
Srednerusskaya forest steppe	2.26	2.31	2.04	2.18	2.20	−0.27
Levoberezhno-Dneprovskaya north steppe	2.10	2.22	2.19	1.84	2.09	−0.38
Mean	2.44	2.73	2.50	2.20	2.47	
Standard deviation	0.62	0.64	0.62	0.47		
Max – maximal yield	3.59	3.84	3.62	3.05		
Min – minimal yield	1.77	2.18	2.03	1.84		
R – amplitude of fluctuations of yield	1.82	1.66	1.59	1.21		
Mistake of arithmetic mean	0.25	0.26	0.25	0.19		
Ve,% – coefficient of variance	2.55	2.35	2.49	2.16		
Hom – homeostatic	0.10	0.12	0.10	0.10		
As – coefficient of agronomic stability	74.5	76.5	75.1	78.4		