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The scientific monograph presents the theoretical and practical aspects of the development of modern scientific research. General questions of economics and enterprise management, regional economics, marketing, technical sciences, technology of food and light industry, and so on are considered. The publication is intended for scientists, educators, graduate and undergraduate students, as well as a general audience.

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STUDY OF THE INFLUENCE OF UNFAVORABLE VEGETATION CONDITIONS ON AGRO-ECOLOGICAL RESISTANCE OF BEAN VARIETIES

Oleksandr Tkachuk[1]
Myroslava Mordvanyuk[2]

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Abstract. Among the leguminous crops in world agriculture, the bean ranks second after soybeans in terms of gross yield and is in great demand as a food product. Beans as a food product is important in the food balance of the country, because its seeds in protein content exceeds cereals in 2-3 times or more, and contains 28-32%, and in green beans (asparagus beans) – 17-21% balanced in amino acid composition of protein, as well as more than 40% of carbohydrates, vitamins A, B, C, E, enzymes, minerals. Despite the significant sown area of beans in the world, which is about 26 million hectares, in Ukraine in 2019, its crops were significantly inferior to the traditional for our country leguminous crops – soybeans and peas and amounted to only 42.0 thousand hectares, which was about 7 % in the structure of leguminous crops. Insignificant bean sown areas in Ukraine are combined with a low seed yield of 1.6 t/ha.

As part of research work of Vinnytsia National Agrarian University, the authors of the research are executors of applied research on the topic: «Development of methods for improving the technology of growing legumes using biofertilizers, bacterial preparations, foliar fertilizers and physiologically active substances» (Mazur V.A., Didur I.M., Tkachuk O.P., Pantsyreva H.V.), state registration number 0120U102034.

1. Introduction

Growing crops and obtaining significant gross harvests is the basis for providing the world's population with food. However, on the way to

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obtaining quality and stable crop products there are a number of obstacles, among which one of the main is low manufacturability varieties. In modern conditions, one of the most important global tasks, in particular in Ukraine, is to ensure a balanced diet. Due to the decline in the production of high-protein livestock products, the problem of increasing the gross harvest of legumes, of which a significant share belongs to common beans, is particularly important [22; 34; 51].

The Forest-steppe is a favorable zone for growing beans in Ukraine, which creates promising prerequisites for increasing the sown area of this crop. However, beans are grown mainly on small household plots of the private sector with a predominance of manual labor. The cultivation of beans under production conditions is hindered by its low productivity, the use of "grandfather" varieties unsuitable for mechanized cultivation and harvesting, vulnerable to adverse environmental factors, the imperfection of the elements of growing technology, and the incomplete use of the possibilities of biological nitrogen fixation, unfavorable factors of organizational and economic nature [2].

Among grain legumes in Ukraine used high demand and belongs to the favorite products nutrition beans [6]. Intensification of growth and development of common bean plants is due to the influence of environmental, edaphic and biotic factors [11; 28; 33], but the dominant role belongs to varieties and cultivation technologies [18; 19; 29; 30; 31; 32]. Domestic breeders offer a number of new high-yielding stem varieties of beans with high seed quality [8; 9; 21; 22].

This situation does not satisfy the existing demand in the volume of bean products and does not allow to control its quality. Therefore, an urgent task is to expand the sown area under beans in agricultural enterprises using modern intensive technologies for its cultivation [3; 7].

Given the variability of the agricultural market, farmers are constantly looking for attractive areas of activity. One of these areas is the cultivation of beans. The precondition for this is the growing demand of the domestic canning industry on the world market. Industrial cultivation beans due to economic and agronomic attractiveness [14; 19]. At the same time, among the main components of technology that determine the growth of bean production efficiency, the selection of varieties is of great importance [13; 21].

2. Analysis of recept research and publications

Industrial cultivation of beans in our country remains problematic, despite the fact that this culture is traditional for Ukraine and is in great demand among the population. Attempts to engage in it in the private sector and in farms of other forms of ownership have not yet brought significant changes. And first of all, because varieties with unstable yields and insufficient manufacturability were still used for growing grain and canning. Therefore, research on the selection and creation of the original breeding material required for the breeding of resistant varieties is becoming increasingly important to biotic and abiotic environmental factors, suitable for intensive technologies, with high grain productivity and early ripening [6–18].

According to well-known scientists, it is proven that growing one varieties in one area under different weather conditions gives a difference in the duration of the growing season, which reaches 10-25 days or more. Precocious samples of common bush type beans are among the most variable [7]. Therefore, it is necessary to analyze the original early-ripening material of common bean type bush, which is in high demand among the population in the private sector, as a culture suitable for consumption in processed form (fresh green beans and seeds) and is low cost for industrial mechanized production. Currently, breeders have made significant progress in creating new varieties of beans. But, despite the large number of varieties, in the selection of this culture there are still many problems. Most of the varieties in production have low resistance to bio- and abiotic environmental factors. And this significantly reduces the stability of seed productivity [8].

A very important area of selection work with this crop is the creation of precocious varieties that will guarantee a stable seed yield. The presence of precocious varieties is relevant for almost all regions of cultivation, because the short growing season solves many problems at once: to move away from early and late frosts, drought, disease and pest damage [9].

As Bakhmat M.I. notes, one of the determining factors in the intensification of bean growing technology is the selection of its varieties. Beans have a high potential seed yield – up to 3.0–4.5 t/ha, which can be achieved with the optimal selection of varieties, taking into account agroecological factors and compliance with the agrotechnical requirements for its cultivation [4].

In the research of Pantsyreva H.V. it is established that due to the high protein content, being a good precursor, low cost of growing legumes is important fodder, agronomic and economic importance, as, today, certain technological factors of growing legumes in the Right Bank Forest-Steppe of Ukraine (variety, pre-sowing seed treatment, foliar feeding), which would ensure the creation of optimal conditions for the formation of maximum photosynthetic, symbiotic and grain productivity of crops in this area are extremely important.

Agroecological factors in the selection of bean varieties are a combination of high yields with product quality, resistance to disease and pest damage. According to Ovcharuk O.V., the extreme weather conditions in recent years requires bean varieties of drought resistance, cold resistance, early ripening [5]. Research Silenko S.I., Duplyaka O.T. and Ganina O.O. showed that technological indicators of bean varieties should be suitability for mechanized cultivation and harvesting, determinism and uprightness of plants by growth characteristics, resistance to bean cracking, simultaneity of seed ripening, high attachment of lower beans to the stem [6–8].

3. Purpose and methods of research

The purpose of our research was to analyze the available bean assortment in terms of productivity and resistance to adverse environmental factors.

Studies to assess the agro-ecological resistance of common bean varieties to adverse growing conditions were carried out on the basis of processing the State Register of Plant Varieties suitable for distribution in Ukraine for 2021 [9], official descriptions of plant varieties and indicators of economic suitability, presented in the official bulletins «Protection of Rights to Plant Varieties», covered in the Information and Reference System «Variety» [10–12], as well as on the materials of scientific research, which presents the productivity indicators of common bean varieties [13–17]. Conducted an analysis of materials on varieties of common beans (grain) and common beans (vegetables).

The resistance of bean varieties to pests, diseases and drought was considered as unfavorable growing conditions. The relative resistance of plant varieties to adverse factors is determined on a nine-point scale (1-9 points), in which 9 points corresponds to the highest resistance, and

1 point – the lowest resistance. The following gradation of grades by points was used: 9 points – excellent variety; 7 points – good variety; 5 points – the variety is satisfactory; 3 points – bad grade; 1 point – the variety is very bad [18].

Potential yield levels of grain bean seeds and green beans were also analyzed. We compared the studied indicators with the use of mathematical-statistical correlation-regression analysis.

The studied indicators of common beans were established on the basis of the Methodology of examination of plant varieties of cereals, cereals and legumes for suitability for distribution in Ukraine. The experiments were performed on plots of 10–25 m^2 with four repetitions [18].

Determination of the main diseases of common beans, in accordance with the requirements of the method [18] was carried out as follows: anthracnose – before harvest by the percentage of affected surface of stems, leaves, beans and seeds; viral mosaic – in the phase of full flowering by the percentage of affected plant surface; angular bacterial spot – during the pouring of the bulk of beans and before harvest by the percentage of affected surface of the stem, leaves, beans and seeds; common spot – during the pouring of the bulk of beans and before harvesting by the percentage of damage to the plant surface.

Grain damage by beans is determined one month after harvest by the percentage of damaged grains. Assessment of drought resistance of bean varieties is carried out in accordance with the general guidelines for visual assessment of plants during the growing season. Plant yield is determined by harvesting them separately or directly [18].

4. Agri-environmental sustainability and potential yields of common grain varieties

The type of common bean Phaseolus vulgaris L. combines two groups of varieties according to economic use: common bean (cereal) and common bean (vegetable). Grain beans belong to the shelling type, which is grown to obtain ripe seeds. This bean is a typical leguminous crop. Vegetable beans are also called sugar or asparagus. In it, unripe fruits have economic use – beans (shoulder blades) with unripe seeds, which are consumed in boiled or stewed form. There are also semi-sugar beans, which occupy an intermediate position between shelling and sugar.

The main unfavorable factors during the growing season of beans are the influence of its diseases, pests, as well as drought. The most dangerous bean diseases are anthracnose, viral mosaic, angular bacterial spot and common spot. The most common bean pest is the bean weevil.

The main adverse factors during the growing season of beans are the impact of its diseases, pests and drought. The most dangerous diseases of beans are anthracnose, viral mosaic, angular bacterial spot and common spot. The most common pest of beans is bean seeds.

Common bean (grain) in the State Register of Plant Varieties of Ukraine for 2021 is represented by 30 varieties. According to the level of potential seed yield, according to the State Register of Plant Varieties of Ukraine, Eureka, Iholomska – 3.0 t/ha, Ros, Mavka – 2.80 t/ha, Yasochka – 2.78 t/ha, Nata – 2.75 t/ha, Shchedra, Assol, Slaviia, Vavelska – 2.70 t/ha. The lowest declared seed yield of grain varieties Fresano, Pervomaiska, Dokuchaievska – 1.50 t/ha, Haidarska, Dvadesiatytsia – 1.70 t/ha. There is no information in the State Register on the yield of grain varieties Zagadka and Zhuravka (Table 1).

The relative resistance of most varieties of common beans to the disease complex is determined by a score of 7 on a nine-point scale. Only the Hotyka variety had the highest resistance to a complex of diseases – 9 points, the Otrada variety had a resistance score of 6, Dokuchaievska – 5, Pervomaiska – 4 points.

Information on the resistance of grain varieties to pests in the State Register of Varieties is only partially written. According to this document, the varieties Haidarska, Hotyka, Oniks, Perlyna, Mavka and Nadiia have a resistance score of 7. There is no information on resistance to pests of other varieties of grain beans in the document.

According to the State Register of Varieties, grain of the Vavelska grain variety has the highest drought resistance – 9 points, Iholomska, Zahadka, Dvadesiatytsia – 8 points each. The least drought-resistant varieties are Pervomaiska – 4 points, Veselka, Yarynka, Dokuchaievska – 5 points each. Most varieties of grain beans are characterized by an average score of drought resistance – 7.

Table 1

Indicators of agro-ecological stability and potential yield of common grain varieties according to the State Register of Plant Varieties of Ukraine

Variety	Resistance to diseases, scores	Drought resistance, points	Seed yield, t/ha
Ros	7	7	2,80
Bilosnizhka	7	7	2,10
Haidarska	7	7	1,70
Eureka	7	7	3,00
Veselka	7	5	2,55
Panna	7	7	2,60
Zahadka	7	8	no data available
Nespodivanka	7	7	2,50
Shchedra	7	7	2,70
Assol	7	7	2,70
Hotyka	9	7	2,10
Slaviia	7	7	2,70
Yasochka	7	7	2,78
Dvadesiatytsia	7	8	1,70
Oniks	7	7	2,50
Otrada	6	7	2,67
Nata	7	7	2,75
Fresano	7	7	1,50
Halaktyka	7	7	2,45
Yarynka	7	5	2,20
Pervomaiska	4	4	1,50
Perlyna	7	5	2,60
Mavka	7	6	2,80
Dokuchaievska	5	5	1,50
Podolianka	7	7	2,65
Bukovynka	7	7	2,63
Nadiia	7	6	2,30
Zhuravka	7	7	no data available
Vavelska	7	9	2,70
Iholomska	7	8	3,00

5. Correlation-regression dependence of grain varieties on adverse factors

Correlation-regression dependencies of the average direct relationship between the potential seed yield of grain bean varieties and their disease resistance score (r = 0.415) were established; between the potential seed yield of grain bean varieties and their drought resistance score (r=0.552); between the resistance score of grain bean varieties to diseases and the score of their drought resistance (r=0.626).

Graphical dependence of the potential seed yield of grain bean varieties (y) on their disease resistance score (x), as well as the regression equations between the studied factors, shown in Figure 1.

Graphical dependence of the potential seed yield of common grain beans (y) on the score of their drought resistance (x), as well as the regression equations between the studied factors, shown in Figure 2.

The graphical dependence of the score of resistance of grain beans to diseases (y) on the score of their drought resistance (x), as well as the regression equations between the studied factors, shown in Figure 3.

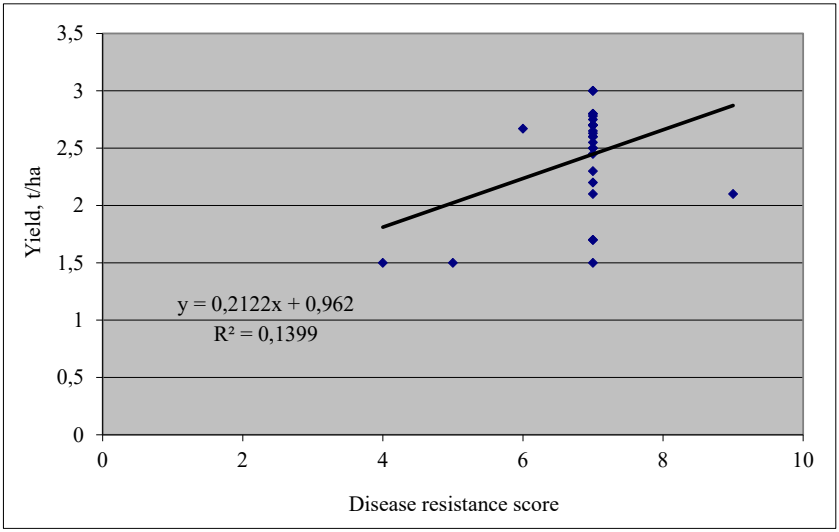

Figure 1. Correlation-regression relationship between the score of resistance of grain beans to diseases (x) and the yield of their seeds (y)

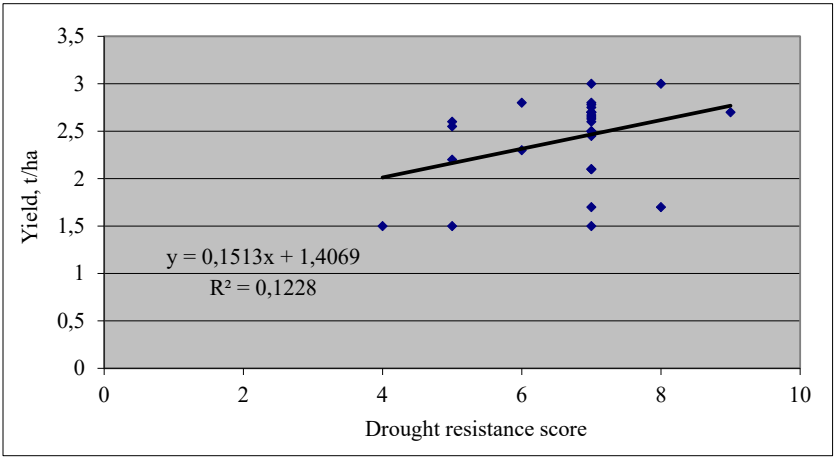

Figure 2. Correlation-regression dependence between the drought resistance score of grain beans (x) and the yield of their seeds (y)

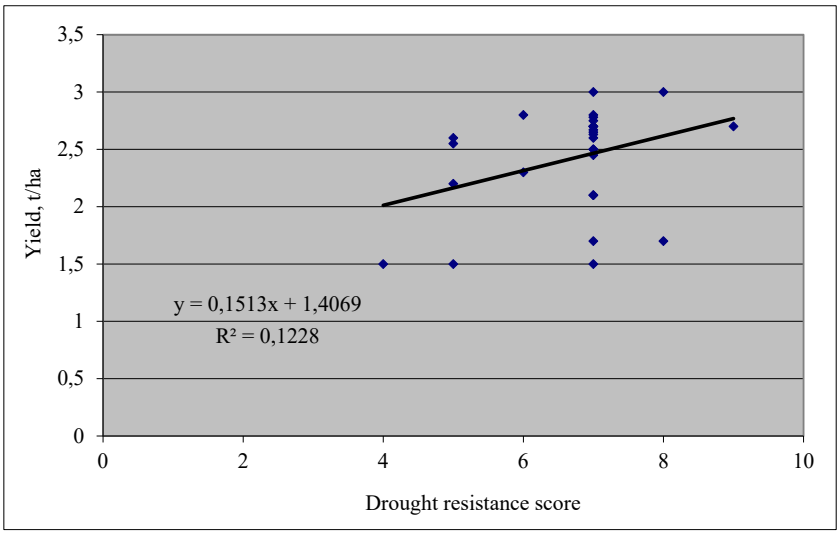

Figure 3. Correlation-regression relationship between the score of drought resistance of grain beans (x) and the score of their resistance to disease (y)

6. Agroecological stability and potential yield of varieties of vegetable beans

The State Register of Plant Varieties of Ukraine for 2021 presents 34 varieties of vegetable beans. Since this bean is harvested by green beans in the scapular phase, it is difficult to calculate its yield, because the State Register for some varieties presents the potential yield in green beans, and for others – in the seeds. The highest potential seed yields, according to the State Register of Plant Varieties of Ukraine, are varieties of vegetable beans Dzhyna, Festival – 2.20 t/ha, Konza – 2.10 t/ha and Delfina – 2.00 t/ha. The lowest seed yield is typical for Kroket varieties – 0.65 t/ha and Paik – 0.70 t/ha (Table 2).

The potential yield of green beans in the State Register of Plant Varieties is indicated only in eight varieties of vegetable beans. According to the available information, the highest potential yields of green beans are Festival – 37.7 t/ha, Faiza – 35.7 t/ha and Festin – 34.6 t/ha. The lowest yield of green beans was observed in the Bohema variety – 8.0 t/ha.

Similar to grain beans, most varieties of vegetable beans have a disease resistance score of 7. Only the Nahano variety has a score of 8, Olha – 6, Festival, Faiza, Festin – 5 points each.

Vegetable bean cultivars Festival and Faiza are noted for increased resistance to pests, having a score of 8. For other cultivars, there is no information on their resistance to pests.

The highest drought resistance of the vegetable bean variety Delfina, Nagano, Shakhinya, Croquet and Festin – 8 points each. The least drought-resistant Teroma – 5 points and Faiza – 6 points.

7. Correlation-regression dependence of grain bean varieties to unfavorable factors

Correlation-regression calculations established an average feedback ($r = -0.376$) between the potential seed yield of vegetable bean varieties and their disease resistance score; strong inverse relationship ($r = -0.968$) between the potential yield of green beans of vegetable bean varieties and disease resistance score; the average direct relationship ($r = 0.626$) between the disease resistance score of vegetable bean varieties and their drought tolerance score.

The graphical dependence of the potential seed yield of vegetable bean varieties (y) on their disease resistance score (x), as well as the regression equations between the studied factors, shown in Figure 4.

Table 2

Indicators of agro-ecological stability and potential yield of varieties of common vegetable beans according to the State Register of Plant Varieties of Ukraine

Variety	Resistance to diseases, scores	Drought resistance, points	Seed yield, t/ha
Zironka	7	7	1,20
Laura	7	7	1,50
Zlatko	7	7	1,90
Pantera	7	7	1,50
Holubka	7	7	1,50
Bohema	7	7	1,50
Tsarivna	7	7	1,20
Palati	7	7	1,70
Beroniia	7	7	1,50
Konza	7	7	2,10
Delfina	7	8	2,00
Nahano	8	8	no data available
Paloma	7	7	no data available
Pop Top	7	7	1,20
Shakhynia	7	8	no data available
Kaprika	7	7	no data available
Klark	7	7	no data available
Fruidor	7	7	1,50
Dzhyna	7	7	2,20
Paulista	7	7	1,30
Unidor	7	7	no data available
Beroniia	7	7	1,50
Festival	5	7	2,20
Kroket	7	8	0,65
Dar	7	7	1,40
Paik	7	7	0,70
Serehneti	7	7	no data available
Outlav	7	7	no data available
Faiza	5	6	1,83
Verdihon	7	7	1,20
Festin	5	8	no data available
Olha	6	5	1,00
Straik	7	7	1,80
Teroma	7	5	1,50

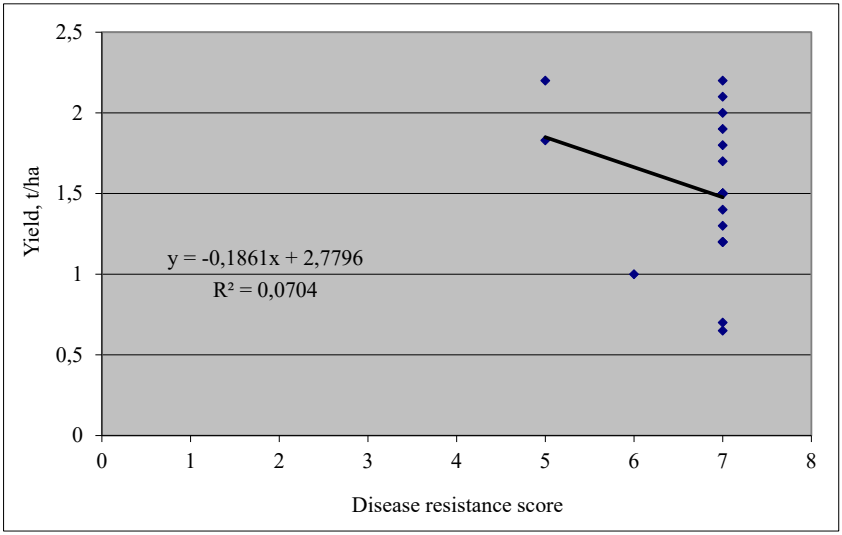

Figure 4. Correlation-regression dependence between the resistance score of vegetable bean varieties to diseases (x) and the yield of their seeds (y)

The graphical dependence of the potential yield of green beans of common vegetable varieties (y) on their disease resistance score (x), as well as the regression equations between the studied factors.

Comparison of the potential seed yield of grain and vegetable bean varieties revealed an excess of the average yield of grain bean varieties by 37.2 % compared to vegetable. Disease resistance in varieties of grain and vegetable beans is the same – 6.8 points each, and resistance to pests in vegetable beans is 12.5 % higher than in grain beans. The drought resistance of vegetable bean varieties is 6.9 % higher than that of grain beans.

8. Conclusions

Intensification of growth and development of common bean plants is due to the influence of environmental, edaphic and biotic factors, but the dominant role belongs to the varieties and cultivation technologies. Domestic breeders offer a number of new high-yielding stem varieties of beans with high seed. Thus, as of 2021, the State Register of Plant Varieties

Suitable for Distribution in Ukraine for 2021 contained 16 varieties of beans for grain use (15 of them – domestic selection).

The intensity of growth processes increases in direct proportion productivity of legumes. In turn, intensification processes of growth and development is determined by the influence of environmental, edaphic and biotic factors. However, the dominant role belongs to varieties and cultivation technologies. An important role in shaping the productivity of legumes is played by technological measures, which with the favorable interaction of unregulated factors can reach 85% or more. In contrast to technological measures, the role of the variety, as one of the most affordable and efficient means of production, is constantly growing and its contribution, according to recent years, in increasing yield is estimated at 30-50%. Among the varieties of grain beans, according to the State Register of Plant Varieties of Ukraine for 2021, the highest potential seed yields are: Eureka, Iholomska, Ros, Mavka, Yasochka, Nata, Shchedra, Assol, Slaviia, Vavelska. The most drought-resistant varieties are Vavelska, Iholomska, Zahadka; to diseases – Hotyka. Among the varieties of vegetable beans, the highest potential seed yields are: Dzhyna, Festival, Konza and Delfina; green beans – Festival, Faiza and Festin. The most resistant to disease was the Nahano variety; to the effects of pests – Festival and Faiza; The most drought-resistant, according to the State Register of Plant Varieties of Ukraine for 2021, are Delfina, Nahano, Shakhynia, Kroket and Festin varieties.

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