Results and discussion. Of the hybrids tested, eight mid-early and two mid-ripening hybrids were distinguished, as their yields were higher than those of the conditional check hybrids by 0.42–2.32 t/ha. In addition to yield, the harvest moisture in grain is an important criterion for evaluating hybrids. In all study years, the harvest moisture in grain of the corn hybrids was at or below the standard. The maximum average yields in 2016–2018 were produced by mid-early hybrids Vektor (8.13 t/ha), KhA Bolid (8.19 t/ha), and Arho (8.13 t/a) and by mid-ripening hybrid UKhL 228 / KhA 408 (7.1 t/ha), exceeding the corresponding conditional check hybrids by 23–24%. When analyzing the corn hybrid yields depending on the growing zone, namely Steppe, Forest-Steppe and Woodlands, we noted that their average yield was 5.58, 8.96 and 7.13 t/ha, respectively. Of the hybrids studied, Vektor and Stavr provided the highest yields of 9.49 t/ha and 9.59 t/ha, respectively, with the grain moisture of 18% in the Forest-Steppe.

Conclusions. The yield level and stability in the corn hybrids of different ripeness groups were evaluated. The hybrids gave high or moderate yields and were noticeable for high agronomic stability, providing consistently high yields under deteriorating growing conditions. Based to the trial results, three mid-early corn hybrids, Liubchyk (FAO 240), Stavr (FAO 290) and Vektor (FAO 270), were included in the State Register of Plant Varieties Suitable for Dissemination in Ukraine.

Key words*: corn, yield, hybrid, ripeness group.*

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RESISTANCE OF SUNFLOWER LINES AND HYBRIDS TO MAJOR PATHOGENES IN THE NORTHERN STEPPE OF UKRAINE

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The Institute of Oil Crops of NAAS has created field infectious backgrounds for common pathogens of sunflower in the region: downy mildew (*Plasmopara helianthi* Novot.), dry head rot (*Rhizopus nigricans* Ehrend), and embellisia blotch (*Embellisia helianthi* (Hansf.) Pidolp. The infection levels in 2005–2020 were determined. The results of comprehensive evaluation of sunflower hybrids and their parents bred at the Institute of Oil Crops of NAAS and the Plant Production Institute named after V.Ya. Yuriev of NAAS in 2017–2020. Accessions high resistance to major pathogens and of high economic value have been selected.

Key words: *sunflower, hybrid, line, resistance, selection, infectious background, pathogen, harmfulness, yield*

Introduction. Biological and genetic features of sunflower, diversity of natural conditions in agronomic zones of its cultivation, as well as agricultural and industrial requirements determine the versatility and specificity of objectives in this crop breeding. Breeding is focused on creation of highly productive hybrids, which are ecologically stable and plastic and show group immunity against diseases.

Literature review and problem articulation. At present, the area sown with sunflower significantly exceeds the scientifically substantiated norms, leading to a significant decrease in qualitative and quantitative indicators of commercial seeds. Due to reduced crop rotations, disease-induced loss of yields increased from 10–15% to 35%. In some years favorable for the development of diseases, losses only from head rot amount to 70% or more [1].

For successful selection of fundamentally new sunflower hybrids with resistance to major pathogens, breeders create artificial infectious backgrounds, allowing for improvement and acceleration of the breeding process [2].

Downy mildew (*Plasmopara helianthi* Novot.) is one of the most harmful diseases of sunflower. Its causative agent is an obligate parasite that infects sunflowers throughout the growing period, but is most harmful at the beginning of ontogenesis. At present, downy mildew epiphytoties occur once every four to five years (previously every 10–12 years). The disease during epiphytoties leads to a significant yield loss of up to 50–60% [1].

Dry head rot (*Rhizopus nigricans* Ehrend) is considered to be no less harmful in Ukraine. The disease manifests itself at the crop maturation onset. Dark brown spots appear on heads. Spots often cover the greater part of the head. Further, the plant tissue becomes macerated and coarsened. Achenes are underdeveloped and stick together, and kernels acquire a bitter taste. The disease becomes especially threatening at high temperatures and low relative humidity. All modern sunflower varieties and hybrids are highly susceptible to this pathogen. It is found in soil, plant remains and on seeds [3]. Due to the oversaturation of crop rotations with sunflower, the disease became epiphytic on a large area under in 2012. The disease spread reached 85.0%, and sometimes 100% [4].

Embellisia helianthi (Hansf.) Pidolp (causing embellisia blotch) spreads its areal in Ukraine, namely in the south and southeast, as sunflower-sown area is enlarged. The disease begins as small necrotic spots on leaves, stems, heads, phyllaries and ray flowers; later the spot diameter increases to 2–3 cm; spots are dark brown, with lighter edges. On stems, spots often are irregular ellipse-shaped, 1–5 cm long. Under frequent rains, spots increase significantly, making leaves, stems and heads dried and causing their death. Plants often become brittle. The pathogen harmfulness depends on the sunflower development phase during ingress of infection, meteorological conditions and the terrain. Especially great yield loss is noted after early ingress of infection (phase of 4–6 true leaves). None of modern sunflower hybrids is immune to this pathogen. The disease used to be considered as quarantine in Ukraine, but currently the disease has been removed from the list of quarantine infections [5]. The pathogen persists on affected plant remains in soil and in seeds. As a result of infection, the oil content in kernels decreases (by 9-14%) and the yield loss can amount to 80% [6].

The system of infectious backgrounds, which includes field and laboratory assessments of resistance under natural, artificial and provocative conditions, is an integral part of sunflower breeding [7]. To obtain reliable indicators of plant resistance, the optimal infectious load with the pathogen inoculum with known initial qualitative and quantitative indicators is created [2, 6].

High harmfulness of common diseases and the requirements of modern agricultural production demand continuous selection to identify lines and hybrids that combine resistance to pathogens and economic value (high yields, high oil content in seeds, optimal length of the growing period, etc.). Some hybrids bred at the Institute of Oil Crops of NAAS are slightly damaged by the pathogens of phomopsis leaf and stem blight and grey mold and tolerant to soil infection of white mold; hybrids with group resistance have been selected [8]. Nevertheless, no studies to find group resistance to the pathogens of dry head rot, embellisia blotch and downy mildew have been conducted in the northern steppe of Ukraine.

Purpose and objectives. The purpose was to establish the manifestation peculiarities of sunflower diseases and their combination with valuable economic traits depending on the genotype, as well as to select the best lines and hybrids for further use in production. To complete this purpose, the following objectives were achieved: to create a stationary infectious background for sunflower; to investigate the manifestation of major diseases of sunflower depending on the year conditions; to assess lines and hybrids for valuable economic characteristics and resistance to several pathogens; to select the best lines and hybrids.

Materials and methods. The phytopathological studies were conducted against the field stationary infectious background at the Institute of Oil Crops of NAAS (IOC NAAS) in 2017–

2020; in the field where sunflower monocrop has been maintained since 2005. To create an infectious background, naturally infected parts of plants, infectious material grown in the laboratory on nutrient substrates, sclerotia of rotting heads, etc. were used. Every year the infectious background is replenished with new strains and races of major necrotrophic and obligate pathogens. The background allows for evaluation of breeding material of sunflower at different stages of the breeding process.

The cultivation techniques were conventional for the northern steppe of Ukraine. The test accessions were sown manually to a depth of 5–7 cm with a seeding rate of four seeds per lineal meter (55,000 plants/ha). The interrow spacing was 0.7 m. The experimental plot area was 54 m^2.

Sunflower lines and hybrids bred at the Institute of Oil Crops of NAAS and the Plant production Institute named after V.Ya. Yuriev of NAAS (PPI nd a V.Ya. Yuriev NAAS) were studied. Sterile analogues of the lines were compared with the check accession (standard) line ZL42A bred at IOC NAAS; lines pollen fertility restorers with line ZL260V bred at IOC NAAS; hybrids with hybrid Vasylyk jointly bred by PPI nd a V.Ya. Yuriev NAAS and the Plant Breeding and Genetics Institute National Center of Seed and Cultivar Investigation (PBGI-NCSCI) (early ripeness standard), with hybrid Darii bred by PPI nd a V.Ya. Yuryev NAAS (mid-early ripeness standard). A total of 60 accessions were tested.

The artificial infectious background for downy mildew (*Plasmopara helianthi* Novot.) has been formed for 16 years (2005–2020) with forced introduction of infectious material [8, 9]. The artificial infectious backgrounds for dry head rot (*Rhizopus nigricans* Ehrend) and embellisia blotch (*Embellisia helianthi* (Hansf.) Pidolp) were initiated in 2012. Infectious material was developed in the Sector of Plant Immunity and Protection of IOC NAAS by growing pure cultures according to V.Yo. Bilai‟s method [10].

Phenological observations (date of 50% of seedlings, date of flowering of 50% of plants, date of physiological maturity of 50% of plants) and phytopathological assessments were performed during the growing period. Resistance of sunflower to the pathogens in the field was evaluated by V.P. Omeliuta‟s method [11]. Measurements were conducted in different phases of the growing period of sunflower plants, with the maximum manifestation of the disease. Every year, starting from 2005, the infectious background level was determined by calculating the percentage of sunflower plants affected by pathogens. The number of sown sunflower seeds was considered 100%. Significance of the plant resistance scores to downy mildew and dry head rot was ensured by infectious loading with inoculum with known indicators of harmfulness. To determine resistance of accessions to the pathogens, we used the currently accepted nine-point scale-classifier of sunflower resistance to fungal diseases: 9 points – very high resistance; 7 points – high resistance; 5 points – weak susceptibility; 3 points – moderate susceptibility; 1 point – strong susceptibility.

Valuable economic characteristics of the tested genotypes were assessed in compliance with the competitive trial method: seed yield (t/ha), 1000-seed weight (g), huskness (%), and oil content in seeds (%). The «germination–physiological maturity» period (GPMP) was determined.

Planning, organization and conduct of the field research and statistical processing of experimental data were performed, as described in [12, 13, 14].

Results and discussion. The experimental fields of scientific crop rotation of the Institute of Oil Crops of NAAS are located in the Zaporizhskyi District of Zaporizhska Oblast. This is the agro-soil zone called «Northern Steppe» and defined as a subzone of the Steppe. The weather in 2017–2020 ranged from unfavorable (2017) to relatively favorable (2019) for sunflower. In 2017, the mean air temperature during the sunflower growing period (MayAugust) (data from the IOC NAAS meteorological station, 47°51′N, 35°90′E) was 23.1°C; in 2018, it was 22.4°C; in 2019, it was 22.6°C; and in 2020, it was 22.5°C (the average value for the period of 19601991 is 20.4°C). In 2017, the precipitation amount during this period was 65.5 mm; in 2018, it was 194.0 mm; in 2019, it was 194.7 mm; and in 2020, it was 198.5 mm (the average value for the period of 19601991 is 185.0 mm). So 2017 turned out to be the hottest and most arid. In addition, different phases of sunflower ontogenesis progressed under stressful conditions. In particular, during the seed filling (August), sunflower suffered the most from high temperatures and water deficit in

2017 and 2018 (27.1 and 24.5°C; 4.0 and 0.0 mm, respectively). The hottest anthesis period (July) was in 2020 (25.5°C and 27.6 mm vs. 22.5°C and 46.1 mm in 2019). The greatest amount of precipitation during the anthesis was recorded in July 2018 (122.0 mm). The year-to-year and month-to-month differences in the weather conditions told on pathogen-induced damage to sunflower plants.

The infectious background fluctuated over the study years (Table 1). From 2005 on, the most remarkable development of downy mildew was observed in 2007 (the percentage of affected plants amounted to 35.9%). During the study period (2017–2020), the most remarkable development of downy mildew was observed in 2017 (the percentage of affected plants was 27.3%), while 2019 was noticeable for the minimum development of this causative agent (7.2% of affected plants). On average, in 2005–2020, 18.7% of plants were affected by downy mildew. The differences in the percentage of affected plants between the study years exceeded the LSD_{05} (2.2%).

Table 1

Percentages of sunflower plants affected by downy mildew, dry head rot and embellisia blotch (artificial infectious background),% [1]), IOC NAAS

Year of assessment	Downy mildew	Dry head rot	Embellisia blotch	Year of assessment	Downy mildew	Dry head rot	Embellisia blotch
2005	17.4	–	–	2013	13,1	65,1	14,3
2006	18.9	–	–	2014	16.1	63.2	15.1
2007	35.9	–	–	2015	28.4	47.1	11.0
2008	17.3	–	–	2016	33.6	79.4	14.0
2009	16.1	–	–	2017	27.3	75.4	14.5
2010	26.1	–	–	2018	10.1	81.4	88.3
2011	14.4	–	–	2019	7.2	82.0	88.8
2012	8.2	80.5	11.1	2020	8.4	82.2	88.8
Mean across the years					18.7	72.9	38.4
LSD_{05} for pair comparisons					2.2	2.9	1.3

Note: [1]) – related to the number of planted seeds.

The dry head rot development reached its peak in 2019-2020 (82.0 and 82.2% of affected plants, respectively) and was minimal in 2015 (47.1% of affected plants). On average, in 2012–2020, 72.9% of plants were affected by dry head rot. The differences in the percentage of affected plants between the study years exceeded the LSD_{05} (2.9%).

Embellisia helianthi developed most in 2018–2020. In 2019–2020, 88.8% of plants were affected by *E. helianthi*, and 88.3% in 2018. The minimum infectious background was observed in 2015: 11.0% plants were affected. On average, in 2012–2020, 38.4% of plants were affected by embellisia blotch. The differences in the percentage of affected plants between the study years exceeded the LSD_{05} (1.3%).

Thus, strong infectious backgrounds of the major pathogens of sunflower were observed in the study years, which allowed for differentiation of the breeding material by resistance and for selection of the best accessions.

The mean resistance scores of the best hybrids and parents to the major pathogens on artificial infectious backgrounds are summarized in Table 2. As to resistance to downy mildew, all these genotypes were classified as resistant (resistance score 7 points). These are line-sterile analogue Skh 1008 A bred by PPI nd a V.Ya. Yuriev NAAS, lines-sterile analogues ZL72A, ZL70A and ZL42A bred by IOC NAAS, and simple sterile hybrid KhZ 1701 A jointly bred by these institutions. Among the lines – pollen fertility restorers, lines Kh114V and Kh720V bred by PPI nd a V.Ya. Yuriev NAAS and check line ZL260V bred IOC NAAS were distinguished. In addtion, jointly bred hybrids Khazar, Koliada and Haichur and hybrids Pervistok and Pryz bred by IOC NAAS were referred to the high resistance group.

As to resistance to dry head rot, line ZL70A turned out to be the best among sterile lines; simple sterile hybrid KhZ1701A, lines-pollen fertility restorers Kh114V and Kh720V, as well as hybrids Khazar, Koliada, Pervistok, and Pryz (resistance score 9 points) were also distinguished. High resistance to embellisia blotch was noted in lines ZL70A and Kh114V, hybrids Khazar, Koliada, Pervistok and Pryz (resistance score 7 points).

Table 2

Resistance of the best sunflower lines and hybrids to the major pathogens (artificial infectious backgrounds; mean score for 2017–2020), IOC NAAS

Line/hybrid	Originator institution	Downy mildew	Dry head rot	Embel-lisia blotch
Skh 1008 A	PPI nd a V.Ya. Yuriev NAAS	7	7	5
ZL72 A	IOC NAAS	7	7	5
ZL70 A	IOC NAAS	7	9	7
KhZ 1701 A	PPI nd a V.Ya. Yuriev NAAS, IOC NAAS	7	9	5
ZL42A (standard)	IOC NAAS	7	7	5
Kh 114 V	PPI nd a V.Ya. Yuriev NAAS	7	9	7
Kh 720 V	PPI nd a V.Ya. Yuriev NAAS	7	9	5
ZL260 V (standard)	IOC NAAS	7	7	5
Khazar	PPI nd a V.Ya. Yuriev NAAS, IOC NAAS	7	9	7
Koliada	PPI nd a V.Ya. Yuriev NAAS, IOC NAAS	7	9	7
Haichur	PPI nd a V.Ya. Yuriev NAAS, IOC NAAS	7	7	5
Pervistok	IOC NAAS	7	9	7
Pryz	IOC NAAS	7	9	7
Vasylyk (standard)	PPI nd a V.Ya. Yuriev NAAS, PBGI-NCSCI	5	7	5
Darii (standard)	PPI nd a V.Ya. Yuriev NAAS	5	5	3
LSD_{05}	–	1.1	1.0	0.4

Thus, among the studied genotypes, there were those that showed group resistance to the major pathogens of sunflower, which are common in the Northern Steppe of Ukraine. These are lines ZL70A and Kh114V, hybrids Khazar, Koliada, Pervistok and Pryz, which are characterized by very high (9 points) or high (7 points) resistance to downy mildew, dry head rot and embellisia blotch. High resistance to two pathogens (downy mildew and dry head rot) was demonstrated by line Kh720V and simple sterile hybrid KhZ1701A. Lines Skh1008A, ZL72A, ZL42A, and ZL260 B and hybrid Haichur were highly resistant to downy mildew.

In addition to the phytopathological assessments, the valuable economic characteristics of the tested genotypes were determined. The „germination – physiological maturity" period in the studied genotypes varied 85 to 105 days (Table 3). The duration of this period in the best hybrids was 95–105 days; in the lines, this period lasted 85–105 days.

As to the «germination–physiological maturity» period, all hybrids with the best resistance belonged to the early group (check hybrid Vasylyk, 105 days); there were no mid-early hybrids (check hybrid Darii, 110 days).

For the study period (2017–2020), the presented lines and their hybrid combinations combined relatively high resistance to major pathogens with high economic indicators. The selected highly resistant lines-sterile analogues gave yields higher than that from the standard ZL42A (0.97 t/ha) by 0.15–0.99 t/ha, which make them attractive for producers of hybrid seeds. The lines - pollen fertility restorers gave yields of 0.34 and 0.48 t/ha, which did not differ significantly from the yield produced by the standard (0.41 t/ha).

Table 3

Economic characteristics of the best sunflower lines and hybrids (mean for 2017–2020), IOC NAAS

Line/hybrid	GPMP, days	Yield, t/ha	1000-seed weight, g	Huskness, %	Oil content in seeds, %
Skh 1008 A	88	1.12	55.3	24.0	48.91
ZL72 A	89	1.76	56.1	23.3	51.12
ZL70 A	90	1.96	56.4	22.7	50.32
KhZ 1701 A	85	2.56	49.5	22.8	49.51
ZL42A (standard)	105	0.97	45.3	22.1	49.26
Kh 114 V	90	0.34	33.1	19.5	49.23
Kh 720 V	90	0.48	36.3	21.2	49.14
ZL 260 V (standard)	95	0.41	35.6	20.2	49.18
Khazar	100	3.42	45.8	22.3	49.86
Koliada	100	3.61	59.1	22.0	50.10
Haichur	95	3.22	46.0	22.1	49.46
Pervistok	95	3.34	58.6	24.6	52.12
Pryz	105	3.58	57.0	23.4	51.88
Vasylyk (standard)	105	3.09	57.5	23.6	49.00
Darii (standard)	110	2.94	49.0	25.4	48.13
Mean	96	2.19	49.4	22.6	49.81
LSD_{05} for pair comparisons	9.4	1.20	6.3	2.6	5.90

The yield from simple sterile hybrid KhZ 1701 A was 2.56 t/ha, which is by 0.60 t/ha higher than that from the best sterile line ZL70A (1.96 t/ha). Hybrid Koliada hybrid derived from KhZ 1701 A (3.61 t/ha) was also the best in terms of yield. Hybrids Khazar (3.42 t/ha), Haichur (3.22 t/ha), Pervistok (3.35 t/ha), and Pryz (3.58 t/ha) also gave high yields, higher than 3.0 t/ha. However, given LDS_{05} of 1.20 t/ha, none of the hybrids exceeded the check hybrid (Vasylyk) in terms of yield.

The 1000-seed weight of the lines – sterile analogue varied 45.3 to 56.4 g; in the lines – pollen fertility restorers, this parameter was in the range of 33.1–36.3 g; in the hybrids, it ranged within 45.8–59.1 g, while the check hybrid (Vasylyk) had the 1000-seed weight of 57.5 g.

The selected accessions had a high percentage of oil in seeds. This parameter ranged 48.91 to 51.12% in seeds of the lines – sterile analogue and did not differ significantly from the oil content in seeds of the standard – line ZL42A (49.26%). The oil content in seeds of the resistant lines - pollen fertility restorers was 49.14–49.23% (at the standard level of 49.18%). The oil content in seeds of the selected resistant hybrids ranged from 49.46% (Haichur) to 52.12% (Pervistok). The oil content in seeds of the check hybrid (Vasylyk) was also high (49.00%).

Conclusions. The artificial infectious backgrounds of the major sunflower pathogens have been created: downy mildew (*Plasmopara helianthi* Novot.), dry head rot (*Rhizopus nigricans* Ehrend) and embellisia blotch (*Embellisia helianthi* (Hansf.) Pidolp). During the study years, the infectious backgrounds were remarkable, which allowed for differentiation of the breeding material by resistance and selecting the best accessions. On average, in 2005–2020, downy mildew affected 18.7% of plants (maximum of 27.3% were observed in 2017). On average, in 2012–2020, 72.9% of plants were affected by dry head rot (maximum of 82.2% in 2020). On average, in 2012–2020, 38.4% of plants were affected by embellisia blotch (maximum of 88.8% in 2019).

A possibility of identifying genotypes with group resistance to the major sunflower pathogens, which are common in the northern steppe of Ukraine, has been proven. These are lines ZL70 A and Kh 114 V, hybrids Khazar, Koliada, Pervistok and Pryz, which are characterized by very high (score 9 points) or high (score 7 points) resistance.

We selected the lines and hybrids combining relatively high resistance to the major pathogens with high levels of economic characteristics. Hybrid Koliada was the best due to its yield (3.61 t/ha). Hybrids Khazar (3.42 t/ha), Haichur (3.22 t/ha), Pervistok (3.35 t/ha), and Pryz also gave high yields, higher than 3.0 t/ha. Since 2020, hybrid Koliada has been in the State Register of Plant Varieties Suitable for Dissemination in Ukraine.

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СТІЙКІСТЬ ЛІНІЙ ТА ГІБРИДІВ СОНЯШНИКУ ДО УРАЖЕННЯ ОСНОВНИМИ ПАТОГЕНАМИ В УМОВАХ ПІВНІЧНОГО СТЕПУ УКРАЇНИ

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Мета досліджень – визначення рівня прояву хвороб соняшнику та їх поєднання з цінними господарськими ознаками залежно від генотипу, а також виділення кращих ліній і гібридів для подальшого використання у виробництві. Для досягнення мети вирішували такі задачі: створення стаціонарного інфекційного фону соняшнику; дослідження рівня прояву основних хвороб соняшнику залежно від умов року; оцінка ліній і гібридів за цінними господарськими ознаками та за стійкістю до комплексу патогенів; виділення кращих ліній і гібридів.

Матеріали та методи. Фітопатологічні дослідження проводили в умовах багаторічної (2005-2020 рр.) монокультури соняшнику, на штучному польовому інфекційному фоні, для створення якого використовували інфіковані в природних умовах частини рослин і лабораторний інфекційний матеріал. Досліджували стійкість ліній і гібридів соняшнику до патогенів, розповсюдженим в умовах північного Степу України: несправжньої борошнистої роси *(Plasmopara helianthi* Novot.*)*, сухої гнилі *(Rhyzopus nigricans* Ehrend*)* і ембелізії *(Embellisia helianthi* (Hansf.) Pidolp*)*. Рівень прояву інфекційного фону визначали шляхом підрахунку відсотка уражених збудниками хвороб рослин соняшнику по відношенню до загальної кількості висіяних сім'янок зразка. За методикою конкурсного випробування проводили облік цінних господарських ознак генотипів. Матеріалом для досліджень були лінії і гібриди соняшнику селекції ІОК НААН та ІР імені В.Я. Юр'єва НААН, всього 60 зразків.

Обговорення результатів. Показник рівня інфекційного фону, визначений як відсоток уражених рослин, коливався за роками досліджень. Розмах мінливості склав: за несправжньою борошнистою росою в 2005-2020 рр. – 7,2-27,3 %; за сухою гниллю в 2012-

2020 рр. – 47,1-82,2 %; за ембелізією в 2012-2020 рр. – 11,0-88,8 %. Виділено лінію-стерильний аналог (ЗЛ70А), лінію-відновник фертильності пилку (Х 114 В) і гібриди (Хазар, Коляда, Первісток і Приз), які мають високу (бал 7) і дуже високу (бал 9) стійкість до трьох досліджених патогенів. Високу стійкість до несправжньої борошнистої роси і сухої гнилі показала лінія Х 720 В, а також простий стерильний гібрид ХЗ 1701 А. За високою стійкістю до несправжньої борошнистої роси виділено лінії Сх 1008 А, ЗЛ72А, ЗЛ42А, ЗЛ260В і гібрид Гайчур.

За роки досліджень цінних господарських ознак (2017-2020 рр.) спостерігали високий рівень інфекційного фону основних патогенів соняшнику, що дозволило виділити кращі зразки, що поєднують високу стійкість (бал стійкості 7 і 9) з високою врожайністю, високою масою 1000 насінин (до 58,6 г), високим умістом олії в насінні (до 52,12 %) і низькою лушпинністю, яка не перевищувала 24,6 %. Тривалість періоду «сходи-фізіологічна стиглість»у кращих за стійкістю гібридів була 95-105 діб, у ліній 85-105 діб. Кращим за врожайністю (3,61 т/га) був гібрид Коляда, спільної селекції ІР імені В.Я. Юр'єва НААН та ІОК НААН. Гібрид Коляда з 2020 року занесено до Державного реєстру сортів рослин, придатних для поширення в Україні.

Висновки. Доведено можливість виділення генотипів (ліній і гібридів) з груповою стійкістю до основних патогенів соняшнику, розповсюдженим в умовах північного Степу України. Виділено лінії та їх гібридні комбінації, які поєднують високу стійкість до основних патогенів з високим рівнем прояву господарських ознак.

***Ключові слова**: соняшник, гібрид, лінія, стійкість, селекція, інфекційний фон, патоген, шкодочинність, урожайність*

УСТОЙЧИВОСТЬ ЛИНИЙ И ГИБРИДОВ ПОДСОЛНЕЧНИКА К ПОРАЖЕНИЮ ОСНОВНЫМИ ПАТОГЕНАМИ В УСЛОВИЯХ СЕВЕРНОЙ СТЕПИ УКРАИНЫ

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Цель исследований – определение уровня проявления болезней подсолнечника и их сочетания с ценными хозяйственными признаками в зависимости от генотипа, а также выделение лучших линий и гибридов с целью дальнейшего производственного использования. Для этого решали такие задачи: создание стационарного инфекционного фона подсолнечника; исследование уровня проявления основных болезней подсолнечника в зависимости от условий года; оценка линий и гибридов по ценным хозяйственным признакам и по устойчивости к комплексу патогенов; выделение лучших линий и гибридов.

Материалы и методы. Фитопатологические исследования проводили в условиях многолетней (2005–2020 гг.) монокультуры подсолнечника, на искусственном полевом инфекционном фоне, для создания которого использовали инфицированные в природных условиях части растений и лабораторный инфекционный материал. Изучали устойчивость линий и гибридов подсолнечника к патогенам, распространенным в условиях южной Степи Украины: ложной мучнистой росе *(Plasmopara helianthi* Novot.*)*, сухой гнили *(Rhyzopus nigricans* Ehrend*)* и эмбелизии *(Embellisia helianthi* (Hansf.) Pidolp*)*. Уровень проявления инфекционного фона определяли путем подсчета процента пораженных возбудителями болезней растений подсолнечника по отношению к общему количеству высеянных семянок образца. По методике конкурсного испытания проводили учет ценных хозяйственных признаков генотипов. Материалом для исследований были линии и гибриды подсолнечника селекции ИМК НААН и ИР имени В.Я. Юрьева НААН, всего 60 образцов.

Обсуждение результатов. Показатель уровня инфекционного фона, определенный как процент пораженных растений, колебался по годам исследований. Размах изменчивости

составил: по ложной мучнистой росе в 2005–2020 гг. – 7,2–27,3 %; по сухой гнили в 2012–2020 гг. – 47,1–82,2 %, по ембелизии в 2012–2020 гг. – 11,0–88,8 %. Выделена линия-стерильный аналог (ЗЛ70А), линия-восстановитель фертильности пыльцы (Х 114 В) и гибриды (Хазар, Коляда, Первісток и Приз), обладающие высокой (балл 7) и очень высокой (балл 9) устойчивостью к трем изученным патогенам. Высокую устойчивость к ложной мучнистой росе и сухой гнили показала линия Х 720 В, а также простой стерильный гибрид ХЗ 1701 А. По высокой устойчивости к ложной мучнистой росе выделено линии Сх 1008 А, ЗЛ72А, ЗЛ42А, ЗЛ260В и гибрид Гайчур.

В годы изучения ценных хозяйственных признаков (2017–2020 гг.) наблюдали высокий уровень инфекционного фона основных патогенов подсолнечника, что позволило выделить лучшие образцы, объединяющие высокую устойчивость (бал устойчивости 7 и 9) с высокой урожайностью, высокой масой 1000 семян (до 58,6 г), высоким содержанием масла в семенах (до 52,12 %) и низкой лузжистостью, которая не превышала 24,6 %. Продолжительность периода «всходы–физиологическая спелость» у лучших по устойчивости гибридов была 95–105 сут., у линий 85-105 сут. Лучшим по урожайности (3,61 т/га) был гибрид Коляда совместной селекции ИР имени В.Я. Юрьева НААН и ИМК НААН. Гибрид Коляда с 2020 года занесен в Государственный реестр сортов растений, пригодных к распространению в Украине.

Выводы. Доказана возможность выделения генотипов (линий и гибридов) с групповой устойчивостью к основным патогенам подсолнечника, распространенным в условиям южной Степи Украины. Выделены линии и их гибридные комбинации, которые объединяют высокую устойчивость к основным патогенам с высоким уровнем проявления хозяйственных признаков.

Ключевые слова: *подсолнечник, гибрид, линия, устойчивость, селекция, инфекционный фон, патоген, вредоносность, урожайность*

RESISTANCE OF SUNFLOWER LINES AND HYBRIDS TO MAJOR PATHOGENES IN THE NORTHERN STEPPE OF UKRAINE

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The purpose was to establish the manifestation peculiarities of sunflower diseases and their combination with valuable economic traits depending on the genotype, as well as to select the best lines and hybrids for further use in production. To complete this purpose, the following objectives were achieved: to create a stationary infectious background for sunflower; to investigate the manifestation of major diseases of sunflower depending on the year conditions; to assess lines and hybrids for valuable economic characteristics and resistance to several pathogens; to select the best lines and hybrids.

Materials and methods. The phytopathological studies were conducted on a long-term (2005–2020) sunflower monocrop, against artificial field infectious backgrounds, for the creation of which we used parts of naturally infected plants and laboratory infectious material. We studied resistance of sunflower lines and hybrids to pathogens widespread in the Northern Steppe of Ukraine: downy mildew (*Plasmopara helianthi* Novot.), dry head rot (*Rhizopus nigricans* Ehrend) and embellisia blotch (*Embellisia helianthi* (Hansf.) Pidolp). The infectious background level was determined by calculating the percentage of sunflower plants affected by pathogens related to the total number of sown achenes of an accession. The valuable economic characteristics of the genotypes were determined in accordance with the competitive trial methods. A total of 60 accessions, sunflower lines and hybrids bred by IOC NAAS and PPP nd a V.Ya. Yuriev NAAS, were studied.

results and discussion. The infectious background level, defined as the percentage of infected plants, fluctuated over the study years. The variability ranges were as follows: for downy mildew in 2005–2020 – 7.2–27.3%; for dry head rot in 2012–2020 – 47.1–82.2%; for embellisia blotch in 2012–2020 – 11.0–88.8%. A line – sterile analogue (ZL70A), a line – pollen fertility restorer (Kh 114 V) and hybrids (Khazar, Koliada, Pervistok and Pryz) with high (score 7 points) or very high (score 9 points) resistance to the three studied pathogens have been identified. High resistance to downy mildew and dry head rot was recorded in line Kh 720 V and simple sterile hybrid KhZ 1701 A. Lines Skh 1008 A, ZL72A, ZL42A, and ZL260V as well as hybrid Haichur were distinguished due to their high resistance to downy mildew.

During the years of studying valuable economic characteristics (2017–2020), high levels of the infectious backgrounds of the major pathogens of sunflower were observed, which made it possible to identify the best accessions combining high resistance (resistance score 7 and 9 points) with high yield, high 1000-seed weight (up to 58.6 g), high oil content in seeds (up to 52.12%) and low huskness (≤ 24.6%). The „germination – physiological ripeness" period in the best resistant hybrids was 95–105 days and, in the lines, it lasted 85–105 days. Hybrid Koliada jointly bred by PPI nd a V.Ya. Yuriev NAAS and IOC NAAS was the best in terms of yield (3.61 t/ha). Since 2020, Koliada has been the State Register of Plant Varieties Suitable for Dissemination in Ukraine.

Conclusions. A possibility of identifying genotypes (lines and hybrids) with group resistance to the major sunflower pathogens, which are common in the Northern Steppe of Ukraine, has been proven. Lines and their hybrids combining high resistance to the major pathogens with high levels of economic characteristics have been identified.

Key words: *sunflower, hybrid, line, resistance, selection, infectious background, pathogen, harmfulness, yield*

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LABORATORY DROUGHT RESISTANCE OF PEA BREEDING ACCESSIONS IN PEG-6000

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The results on the laboratory drought resistance determined by germination of pea seeds in 8.6% PEG-6000 are presented. The depression of root and shoot growth processes was determined for seeds harvested in different years (2018–2020). The depression of the «root length» trait in pea accessions represented by varieties and breeding material varied -96.3% to 67.8%, and the depression of the "shoot length" trait was not negative across the study years, ranging 8.3 % to 91.7%. The obtained data on the depression of growth processes in the pea accessions in PEG-6000 are not mature and require further, more in-depth studying.

Key words*: pea, PEG-6000, depression of growth processes, rank of depression index, variety, breeding lines.*

Introduction. Drought resistance of agricultural plants is a feature that acquires a special status under current climatic conditions. The ability of crops not only to survive, but also to show certain performance on farms, ensures the stable food security of a country and the world.