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

Shevchenko L.M.
Plant Production Institute nd. a. V.Ya. Yuriev of NAAS, Ukraine

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.

Literature review. Evaluation of drought resistance of a crop is not only important practical work, but also work that requires a special methodology and choice of the most objective and effective methods. Here, it is important not only to determine the level of drought resistance of plants, but also to understand the mechanism of resistance and possibilities of its regulation [1].

It is of growing importance to evaluate drought resistance of specimens from genetic banks of different regions, which are a reserve for solving the challenge of creating drought-resistant varieties of different crops [2]. Comprehensive studies of collection pea accessions of different agroecological groups with their subsequent inclusion in breeding considerably enhance the use of the genetic potential of the crop. [3].

Cokkizgin A. et al. [4] observed a response of varieties to germination in PEG-6000 solutions with various osmotic pressure (-0.3, -0.6, -0.9 and -1.2 MPa). Marjani A. et al. [5] reported that the greatest differentiation by growth processes in pea occurred at an osmotic pressure of 6.0 bars.

The use of 23.0% PEG 6000 (semi-lethal dose (LD50)) for selection of millet accessions for drought resistance in the early stages of ontogenesis is the most effective for differentiation of genotypes during germination [6]. When establishing semi-lethal doses for *Pennisetum glaucum* (L.) R. Br. in *in vitro* culture, the authors found that 262 g/L and 242 g/L were working concentrations for germination percentage and coleoptiles emergence, respectively [7].

Similar studies are conducted on other crops. Thus, in Koskosidis A. et al.‟s study on chickpea (*Cicer arietinum* L.) with various concentrations of PEG-6000 (0, 5, 10, 20, 30 and 50% PEG), significant differences in the seed germinability were noted between 20% and 30%, in fact it decreased to 61.8% and 22.0%, respectively. However, the accessions‟ response to stress was individual [8].

Depression of growth processes during germination in PEG-6000 solutions of different concentrations was reported for lentil, which is the most drought-resistant legume. Significant varietal response was observed not only for the depression level, but also for the proline and soluble carbohydrate contents and for ά-amylase activity [9]. A similar response to drought stress was found in two pigeon pea (*Cajanus cajan* L.Millsp.) varieties by Punya S.D.S. and Sujatha B. [10]. Determining the free proline content, lipid peroxidation and activities of several antioxidant enzymes in two canola (*Brassica napus* L.) varieties, Rezayian M. et al. also found significant differences between accessions depending on PEG-6000 concentration [11]. In a study of the osmotic stress effect, Heikal M.M.D. and Shaddad M.A. showed that the proline level in cotton (*Gossypium barbadense* var. Dandara), pea (*Pisum sativum* var. Marvel) and wheat (*Triticum vulgäre* var. Giza 156) was different. However, its content changed unidirectionally in all crops, depending on the stress strength [12]. Moreover, it was found that when *Coix lacryma* -jobi L. was germinated in PEG-6000 solutions of different concentrations, the peroxidase, catalase, ascorbate peroxidase and glutathione reductase activities increased in solutions with osmotic pressure of -0.05 − -0.1 MPa compared to control, while in other cases their activities were even lower than the values [13].

The use of PEG-6000 in combination with NaCl is also effective for assessments of drought resistance and effects of salt stress in pea [14, 15].

When determining the effect of double stressor (PEG-6000 + NaCl) on *Medicago sativa* (L.), *Astragalus adsurgens* (Pall.) and *Coronilla varia* (L.), the researchers determined that *M. sativa* (L.) was the resistant to the stress factors (50 or 100 mM NaCl + 5% or 10% PEG-6000) [16].

Soboleva H.V. et al. tested regenerant pea lines obtained on selective media containing 15-20% PEG -6000 for water-holding capacity in the laboratory and for yield in the field and showed that the obtained lines outperformed the original accessions in terms of physiological parameters of drought resistance and economic characteristics [17].

Experimental data on the efficiency of selective systems with 15% PEG-6000 for comparative evaluation of chameleon pea for relative resistance to water stress are available. It was found that the response to osmotic stress differed both between the studied chameleon pea accessions in comparison with the control. Chameleon plants were demonstrated to have a higher water-holding capacity during wilting than controls [18]. The possibility of selection of drought-resistant breeding lines of pea due to germination of hybrid seeds on selective 15% PEG -6000-containing media in the first stages of breeding was proven [19].

The effectiveness of PEG-6000 solutions of different concentrations was shown in *in vitro* studies. Thus, it was proven that, to determine resistance to osmotic stress at the cellular level, it is possible to use callus tissues of different *in vitro* passages. [20]. It was shown that selective 15% PEG-6000-containing media allowed testing pea genotypes for resistance to water deficit both at the initial stages of plant development and at the level of cell populations *in vitro*. It was found that lines with multi-divided odd-pinnate leaves were on average more resistant to water stress compared to lines of dissected leaves [21]. It was also found that pea callus cultures, which were selected *in vitro* for resistance to osmotic stress, retained the ability to regenerate shoots. Thus, the possibility of using *in vitro* selective systems that simulate water stress to expand the starting material assortment in pea breeding was demonstrated [22]. Zinchenko M.O. et al. showed that a selective mannitol-containing system, compared to different concentrations of PEG-6000, was more effective because it provided a more complete elimination of susceptible cells and higher viability of regenerant plants of bread wheat [23].

Thus, our purpose was to evaluate the laboratory drought resistance of pea varieties and breeding material in PEG-6000.

Materials and methods. Seeds harvested in 2018 - 2020 were investigated. Fifty-nine pea (*Pisum sativum* L.) accessions (breeding varieties, breeding material, collection specimens) were tested.

Pea seeds were germinated in 8.6% PEG-6000 [24]. Control seeds were germinated in distilled water. The germination temperature was 20°C. On day 7, the shoot and root lengths were measured in the control and experiment.

The depression of growth processes was defined as (1):

$$Z = 100 - (\frac{y}{x} * 100\%), \qquad (1)$$

where x is the mean control value;

y is the mean value in PEG-6000.

Experimental data were statistically processed [25].

Results and discussion. The depression of pea root and shoot growth processes in the varieties and breeding lines of the Laboratory of Grain Legume Breeding is summarized in Tables 1 and 2.

Table 1

Ranks of pea accessions for the depression of the «root length» trait,%

Accession	2018	Rank	2019	Rank	2020	Rank
SL 15-95	8.5	10	-21.7	7	-25.0	2
Ramonskiy 77	14.1	17	7.4	18	-33.6	1
Zekon	22.5	21	-45.2	2	5.7	18
Hotik	0.4	8	-37.2	3	30.9	39
Maskara	22.7	22	-32.0	4	26.7	32
Otaman	58.5	48	-22.7	6	27.5	34
Mahnat	51.1	44	42.5	37	-8.5	11
SL 5-185	60.3	50	27.7	28	32.9	41
Deviz	58.8	49	15.4	19	51.9	52
Metsenat	56.9	47	58.2	52	25.0	29
SL 5-186	32.5	30	53.7	50	46.5	50
Korvet	49.2	42	67.7	53	29.0	37
Rezonator	35.2	33	25.9	27	34.7	43
Chekryhinskyi	67.8	53	48.7	46	40.4	48
Vysatyi 90	8.6	11	18.7	22	36.6	45
SL 17-62 lyst	10.5	13	28.5	29	27.5	35
Vasatyi 82	-28.8	3	36.1	33	46.1	49
V,%	42.2	–	205.4	–	127.2	–

Table 2

Ranks of pea accessions for the depression of the «shoot length» trait,%

Accession	2018	Rank	2019	Rank	2020	Rank
SL 15-95	48.6	8	49.4	13	35.6	6
Ramonskiy 77	53.4	16	53.5	16	22.0	2
Zekon	52.2	15	14.1	2	41.4	11
Hotik	38.1	3	34.9	6	51.1	16
Maskara	50.8	11	44.4	9	54.0	22
Otaman	54.7	18	28.6	4	54.9	25
Mahnat	29.1	2	71.8	34	42.1	12
SL 5-185	74.1	45	51.3	14	62.3	36
Deviz	79.5	47	52.7	15	59.4	30
Metsenat	51.4	13	81.3	49	53.6	19
SL 5-186	50.8	12	75.0	41	72.0	45
Korvet	54.7	19	77.0	44	42.3	13
Rezonator	73.0	43	58.6	22	79.2	49
Chekryhinskyi	88.7	53	64.8	25	64.3	40
Vysatyi 90	70.9	40	66.0	29	81.2	51
SL 17-62 lyst	73.6	44	79.1	46	62.7	37
Vasatyi 82	51.5	14	76.5	43	79.4	50
V,%	23.0	-	41.0	-	28.3	-

Across the study years, the depression of the “root length” trait in the 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 in the study years, ranging 8.3% to 91.7%. Bilgili et al. also observed a significant depression of root and shoot growth processes as well as individual responses of five wheat accessions to the germination of seeds in PEG-6000 solutions of different concentrations [26]. Similar response of growth processes was observed during germination of *Coix lacryma -jobi* L. in PEG-6000 solutions of different concentrations (0, −0.05, −0.1, −0.15, and −0.2 MPa) [13]. When resistance of pea vine (*Lathyrus sativus* L.) to water stress was assessed, it was determined that water deficit significantly affected the stem and root lengths, but had negligible effect on branching and leaf area [27].

The root length depression in the pea accessions ranged -52.1% to 67.8% in 2018, -96.3% to 67.7% in 2019, and -33.6% to 61.6% in 2020. The shoot length depression also varied significantly across the study years: from 22.3% to 88.7% in 2018, from 8.3% to 91.7% in 2019, and from 15.8% to 87.1% in 2020.

If we take into account the significant values of the coefficient of variation for the depression of root growth processes, it may confirm the fact that differences in the response to drought can be predicted from this trait. Soboleva H.V. and Beliaev R.V. also established that, upon determining drought resistance of collection pea accessions in solutions of osmotically active substances, it was necessary to comprehensively analyze such physiological parameters as the relative resistance and root growth index. The largest difference between the studied accessions in their responses to osmotic stress was seen by root growth index [28].

For the convenience of analysis of the obtained data, the accessions were ranked according to the depression of "root length" and "shoot length" traits.

It should be noted that are the varieties that were created in the 1990s (leafless varieties Vusatyi 90 and Vusatyi 82 and leafy grain-hay variety Rezonator) are at the bottom of Tables 1 and 2. Comparing the laboratory drought resistance of leafy and leafless pea accessions, we observed no significant differences between these types. However, when the *in vitro* resistance to osmotic stress at the cellular level was compared between the leafy and leafless pea genotypes, the leafy genotypes were on average slightly more resistant to osmotic stress compared to leafless ones [20].

It should be noted that the coefficient of variation for the depression of the «shoot length» trait in 2018 and 2020 was high (23.0% and 28.3%, respectively) and very similar (Table 2). In

general, no stimulatory effect of PEG-6000 was observed for this parameter, unlike the «root length» trait in some accessions.

Despite the fact that Zekon, Hotik and Mascara are varieties bred in Western Europe, they were among the best ones in this sample according to the depression level.

Of the pea accessions bred at PPI NAAS, breeding line SL 15-95 was the best one; variety Ramonskiy 77, a leafy variety bred in the USSR, was highly resistant, judging from the depression of growth processes.

It should be noted that in our experiments the depression level of growth processes in PEG-6000 was not associated with yield (Table 3).

Table 3

Distribution of the pea accessions with the lowest values of the depression ranks of the "root length" and «shoot length» traits, 2018–2020

Accession	Depression rank sum		Total rank sum	Yield, t/ha
	Root	Shoot		
SL 15-95	23	33	56	1.86
Kamelot	51	15	66	1.49
Zekon	41	28	80	1.53
Ramonskiy 77	36	34	83	1.49
Hotik	57	32	89	1.90
Baryton	47	69	116	1.45
SL 11-105	31	93	124	1.97
Blohodatnyi	50	83	133	1.76

Thus, the accession with the lowest rank sum, SL 15-95, gave an average yield of 1.86 t/ha in 2018–2020. At the same time, Rezonator, a variety with the rank sum of 261, produced 1.84 t/ha (Table 4), and Hotik with the rank sum of 89–1.90 t/ha. At the same time, Ramonskiy 77 with the rank sum of 83 gave a yield of 1.49 t/ha, and Chekryhinskyi with the largest rank sum in the experiment (294) gave a yield of 1.33 t/ha.

Table 4

Distribution of the pea accessions with the highest values of the depression ranks of the «root length» and «shoot length» traits, 2018–2020

Accession	Depression rank sum		Total rank sum	Yield, t/ha
	Root	Shoot		
SL 15-161	77	125	202	1.51
SL 17-62 lyst	86	142	228	1.95
Vusatyi 90	87	135	222	1.37
Vusatyi 82	93	144	237	1.53
SL 05-189	100	126	226	1.32
Heizer	110	121	231	1.49
Rezonator	118	143	261	1.84
Hlians	120	117	237	1.47
Svit	121	97	218	1.65
SL 16-80	122	103	225	2.24
Гайдук	123	112	235	1.68
Damyr 2	125	118	243	1.39
SL 05-185	132	108	240	1.34
Deviz	134	105	239	1.42
Metsenat	141	92	233	1.42
SL 05-186	143	111	254	1.27
Korvet	146	85	231	1.33
Chekryhinskyi	160	134	294	1.33

Another issue we tried to address in the study was the seed reproduction number required to determine the laboratory drought resistance. The Spearman coefficient for the matrices of depression ranks showed high identity. Thus, the Spearman coefficient (r_s) was 0.98 between the matrices for all study years. Hence, to determine the laboratory drought resistance by germination in PEG-6000, it is sufficient to replicate the experiment on seeds harvested in two years.

Conclusions. Thus, 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 study.

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ЛАБОРАТОРНА ПОСУХОСТІЙКІСТЬ СЕЛЕКЦІЙНИХ ЗРАЗКІВ ГОРОХУ НА РОЗЧИНІ ПЕГ-6000

Шевченко Л.М.
Інститут рослинництва імені В.Я. Юр'єва НААН, Україна

Представлені результати встановлення лабораторної посухостійкості шляхом пророщування насіння гороху у розчині ПЕГ-6000 концентрації 8,6%. Визначено рівень депресії ростових процесів кореня і пагону на насінні різних років репродукції (2018–2020 рр.). **Мета дослідження** полягала у встановленні лабораторної посухостійкості шляхом пророщування насіння гороху у розчині ПЕГ-6000 концентрації 8,6%.

Матеріали і методи. В якості дослідного об'єкта використовували насіння репродукції 2018–2020 рр. 59 зразків гороху посівного (*Pisum sativum* L.), представлених селекційними сортами, селекційним матеріалом та колекційними зразками. Насіння гороху про-

рощували на розчині ПЕГ-6000 концентрацією 8,6%. Контрольний варіант був пророщений на дистильованій воді. Температура при пророщуванні становила 20°С. На сьому добу вимірювали довжину пагону і корінців на контролі і досліді та визначали депресію ростових процесів.

Обговорення результатів. За роки досліджень рівень депресії довжини корінця у зразків гороху, представлених сортами та селекційним матеріалом, варіював з -96,3% до 67,8%, а показник депресії ознаки довжина пагону за роки досліджень не мав від'ємних значень і становив від 8,3% до 91,7%. Рівень варіювання депресії показника довжина корінця у зразків гороху у 2018 році становив від -52,1% до 67,8 %, у 2019 році -96,3% до 67,7%, у 2020 році -33,6% до 61,6%. Рівень депресії ознаки довжина пагону також значно варіював за роками і становив у 2018 році від 22,3% до 88,7 %, у 2019 році від 8,3% до 91,7 %, у 2020 році від 15,8 % до 87,1%.

Якщо взяти до уваги значний рівень коефіцієнта варіації депресії ростових процесів кореня, то це може підтвердити той факт, що відмінності у рівні реакції на посуху можна прогнозувати за цією ознакою. Для зручності аналізу отриманих результатів було проведено ранжування зразків за показником депресії ознаки «довжина корінця» та «довжина пагону». Слід звернути увагу, що рівень коефіцієнту варіації показника депресії ознаки «довжина пагону» у 2018 та 2020 рр. був високим (23,0% та 28,3%), але практично тотожним. І в цілому, по цьому показнику не спостерігали стимулюючої дії розчина ПЕГ-6000, як це було щодо ознаки «довжина кореня» у деяких зразків. Враховуючи той факт, що зразки Зекон, Готік, Маскара є сортами західноєвропейської селекції, але за рівнем показника депресії вони виявились одними з групи найкращих серед зразків саме цієї вибірки. Серед зразків гороху селекції ІР НААН найкращою була селекційна лінія СЛ 15-95. Сорт Рамонский 77, листочковий сорт ще радянської селекції, виявився високостійким за рівнем депресії ростових процесів. Необхідно відмітити, що рівень депресії ростових процесів, визначений нами на розчині ПЕГ-6000, виявився не пов'язаним із рівнем урожайності. Так, зразок із найменшою сумою рангів СЛ 15-95 мав у середньому за 2018–2020 рр. урожайність на рівні 1,86 т/га. В той же час сорт Резонатор із сумою рангів 261 – 1,84 т/га, сорт Готік, у якого сума рангів 89 – 1,90 т/га, зразок Рамонский 77 із сумою рангів 83 мав показник урожайності 1,49 т/га, а Чекригінський із найбільшою сумою рангів у досліді 294 мав показник урожайності 1,33 т/га.

Розрахований нами коефіцієнт Спірмена для матриць рангів показників депресії показав високу тотожність. Так, між матрицями за всі роки досліджень рівень коефіцієнта Спірмена становив $r_s = 0,98$. Таким чином, для встановлення лабораторної посухостійкості методом пророщування на розчині ПЕГ-6000 достатнім є повторення досліджень на насіннєвому матеріалі двох років репродукції.

Висновки. Таким чином, отримані характеристики зразків за рівнем депресії ростових процесів на розчині ПЕГ-6000 не є остаточними і потребують подальшого, більш глибокого вивчення.

Ключові слова: *горох, ПЕГ-6000, рівень депресії ростових процесів, ранг показника депресії, сорт, селекційна лінія.*

ЛАБОРАТОРНАЯ ЗАСУХОУСТОЙЧИВОСТЬ СЕЛЕКЦИОННЫХ ОБРАЗЦОВ ГОРОХА НА РАСТВОРЕ ПЭГ-6000

Шевченко Л.Н.
Институт растениеводства имени В.Я. Юрьева НААН, Украина

Цель исследования состояла в определении лабораторной засухоустойчивости посредством проращивания семян гороха в растворе ПЭГ-6000 концентрации 8,6%.

Материалы и методы. Исследования проводили на семенах трех лет репродукции – 2018-2020 гг. Всего в исследовании было 59 образцов гороха посевного (*Pisum sativum* L.),

представленных селекционным материалом и коллекционными образцами. Семена опытного варианта проращивали на растворе ПЭГ-6000 концентрации 8,6%. Контрольный вариант – дистиллированная вода. Температура проращивания 20°С. На седьмые сутки измеряли длину проростка и корешка на контроле и опыте, и рассчитывали показатель депрессии ростовых процессов.

Обсуждение результатов. Полученный показатель депрессии ростовых процессов корня у образцов гороха как селекционного материала, так и коллекционных образцов варьировал в диапазоне от -96,3% до 67,8%, а показатель депрессии длины побега за годы исследования изменялся от 8,3% до 91,7%. Необходимо отметить, что у побегов, в отличии от корешков, показатель депрессии был положительным. А у некоторых образцов при проращивании в опытном варианте наблюдали активный прирост длины стебля, что мы объясняем именно ответной реакцией на стрессовый фактор. Также этот показатель изменялся и по годам исследования: на семенах 2018 года он составлял от -52,1% до 67,8 %, в 2019 году -96,3% до 67,7%, в 2020 году -33,6% до 61,6%. Уровень депрессии длины побега также изменялся: в 2018 году он принимал значение от 22,3% до 88,7 %, в 2019 году от 8,3% до 91,7 %, в 2020 году от 15,8 % до 87,1%. Если принять во внимание значительный уровень показателя коэффициента вариации депрессии ростовых процессов корешков опытных образцов, то можно сделать вывод, о значимости данного показателя при оценке на засухоустойчивость. Также следует обратить внимание, что уровень вариации показателя депрессии признака «длина побега» в 2018 и 2020 гг. был высоким (23,0% та 28,3%). И по этому признаку мы не увидели стимулирующего действия раствора ПЭГ-6000, как это было на корешках у некоторых образцов. Для удобства анализа результатов мы провели ранжирование образцов по уровню показателя депрессии признаков «длина корешка» и «длина побега». Образцы гороха Зекон, Готик и Маскара – сорта западноевропейской селекции, но они оказались одними из лучших по уровню лабораторной засухоустойчивости (по уровню депрессии ростовых процессов корня и побега). Среди образцов гороха селекции Института растениеводства имени В.Я. Юрьева лучшей была селекционная линия СЛ 15-95. Сорт Рамонский 77 – листочковый сорт еще селекции советского периода, также оказался достаточно устойчивым. Необходимо отметить, что уровень депрессии ростовых процессов образцов оказался не связанным с уровнем урожайности в полевых условиях. Так, образец СЛ 15-95с наименьшей суммой рангов (56 – самый высокоустойчивый) в среднем за 2018-2020 гг. сформировал урожайность 1,86 т/га, сорт Резонатор с суммой рангов 261 – 1,84 т/га, сорт Готик (сумма рангов 89) – 1,90 т/га, сорт Рамонский 77 (сумма рангов 83) – 1,49 т/га, а сорт Чекрыгинский, сумма рангов которого была наибольшей в опыте – 294, урожайность показывал невысокую – 1,33 т/га.

Рассчитанный нами коэффициент Спирмена для матриц рангов показал высокую степень тождественности между ними – $r_s = 0,98$. Таким образом, для проведения лабораторных оценок на засухоустойчивость достаточным будет оценка образца по семенам двух лет репродукции.

Выводы. Таким образом, полученные характеристики образцов по уровню лабораторной засухоустойчивости (депрессии ростовых процессов) на растворе ПЭГ-6000 не являются окончательными и требуют дальнейшего, более глубокого изучения.

Ключевые слова: *горох, ПЕГ-6000, уровень депрессии ростовых процессов, ранг показателя депрессии, сорт, селекционная линия.*

LABORATORY DROUGHT RESISTANCE OF PEA BREEDING ACCESSIONS IN PEG-6000

Shevchenko L.M.
Plant Production Institute nd. a. V.Ya. Yuriev of NAAS, Ukraine

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 study purpose was to evaluate the laboratory drought resistance of pea varieties and breeding material in PEG-6000.

Materials and methods. Seeds harvested in 2018–2020 were investigated. Fifty-nine pea (*Pisum sativum* L.) accessions (breeding varieties, breeding material, collection specimens) were tested. Pea seeds were germinated in 8.6% PEG-6000. Control seeds were germinated in distilled water. The germination temperature was 20°C. On day 7, the shoot and root lengths were measured in the control and experiment and the depression of root and shoot growth processes was evaluated.

Results and discussion. Across the study years, the depression of the «root length» trait in the 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 in the study years, ranging 8.3% to 91.7%. The root length depression in the pea accessions ranged -52.1% to 67.8% in 2018, -96.3% to 67.7% in 2019, and -33.6% to 61.6% in 2020. The shoot length depression also varied significantly across the study years: from 22.3% to 88.7% in 2018, from 8.3% to 91.7% in 2019, and from 15.8% to 87.1% in 2020.

If we take into account the significant values of the coefficient of variation for the depression of root growth processes, it may confirm the fact that differences in the response to drought can be predicted from this trait. For the convenience of analysis of the obtained data, the accessions were ranked according to the depression of «root length» and «shoot length» traits. It should be noted that the coefficient of variation for the depression of the «shoot length» trait in 2018 and 2020 was high (23.0% and 28.3%, respectively) and very similar. In general, no stimulatory effect of PEG-6000 was observed for this parameter, unlike the «root length» trait in some accessions. Despite the fact that Zekon, Hotik and Mascara are varieties bred in Western Europe, they were among the best ones in this sample according to the depression level. Of the pea accessions bred at PPI NAAS, breeding line SL 15-95 was the best one; variety Ramonskiy 77, a leafy variety bred in the USSR, was highly resistant, judging from the depression of growth processes. It should be noted that in our experiments the depression level of growth processes in PEG-6000 was not associated with yield. Thus, the accession with the lowest rank sum, SL 15-95, gave an average yield of 1.86 t/ha in 2018–2020. At the same time, Rezonator, a variety with the rank sum of 261, produced 1.84 t/ha; Hotik with the rank sum of 89–1.90 t/ha. Ramonskiy 77 with the rank sum of 83 gave a yield of 1.49 t/ha, and Chekryhinskyi with the largest rank sum in the experiment (294) gave a yield of 1.33 t/ha.

The Spearman coefficient for the matrices of depression ranks showed high identity. Thus, the Spearman coefficient (r_s) was 0.98 between the matrices for all study years. Hence, to determine the laboratory drought resistance by germination in PEG-6000, it is sufficient to replicate the experiment on seeds harvested in two years.

Conclusions. Thus, 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 study.

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