UDC:633.2:631.563 2,SJU

ZADOROZHNA O. A. HERASIMOV M. V., SHYIANOVA T. P.
Plant Production Institute nd. a. V.Ya. Yuriev of NAAS
National Center for Plant Genetic Resources of Ukraine
142, Moskovskyi ave., Kharkiv ,61060, Ukraine
E-mail: olzador@ukr.net

GRASSES SEED STORAGE UNDER GENBANK CONDITIONS

The seed viability of 86 acessions of fodder grasses: awnless brome (*Bromopsis inermis* (Leyss.) Holub.), orchardgrass (*Dactylis glomerata* L.), Timothy grass (*Phleum pretense* L.), crested wheat grass (*Agropyron cristatum* (L.) Gaertn.), clustered wheat grass (*Agropyron desertorum* (Fisch. ex Link) Schult. et Scult.f.), annual ryegrass (*Lolium multiflorum* Lam.), perennial ryegrass (*L. perenne* L.), red fescue *(Festuca rubra* L.), meadow fescue (*Festuca pratensis* Huds.), gigantea fescue (*Festuca gigantea* (L.) Vill.), blue fescue (*Festuca inarmata* Schur. (*Festuca amethystina* (Hack. ex Boiss.) St.-Yves)), tall fescue (*Festuca arundinacea* Schreb.), tall oat-grass (*Arrhenatherum elatius* (L.) P. Beauv. ex J. S. et K. B. Presl.), slender wheat grass (*Roegneria trachycaulon* (Link) Nevski), creeping bent grass (*Agrostis alba* L.*)*, redtop (*Agrostis gigantea* Roth.), which were stored under controlled temperature and moisture content 3 – 6 % was investigated. It has been determined that the seeds of these species have different longevity at different storage temperatures under the genebank conditions. *Phleum pretense*, *Phleum pretense*, *Agropyron cristatum*, *Lolium multiflorum Festuca rubra* seed viability was without changing after storage at temperature 4^{o}C for 10 years and longer. The best seed longevity of grasses were achieved when the seeds are kept at –20^{o}C. Accessions features of different grasses species seed storage are discussed.
Key words: *grasses, seeds, gene pool, storage, longevity, temperature, moisture content, germination*

INTRODUCTION

Forage grasses breeding which plays a significant role in the creation of the forage base for dairy cattle is given great attention [1]. Modern breeding methods are used to yield increase [2, 3]. An important condition for the effective provision of breeding programs by the source material is its concentration in the National genebank, work collections of breeding institutions and long-term seed storage in a high viability and genetic authenticity state. As a rule, in the case of fodder crops, the genepool accessions storage is carried out in seeds form. There are general requirements for the seeds of fodder grass DSTU 8518: 2015 [4].

Special conditions for seed storage of grasses genetic resources were chosen. The investigation of the viability of the grasses seeds which stored in an airtight container, first at 15 – 20^{o}C, and than at 7 – 8^{o}C was conducted. The seed viability of *Agrostis, Phleum,* fow bluegrass (*Poa palustris* L.), *Festuca rubra* after 18 years of storage under these conditions was above 60 %, wheares seed viability of *Dactylis glomerata*, *Festuca pratensis*, meadow brome (*Bromopsis erecta* (Huds.) Fourr.), *Lolium perenne* was in the range of 20 – 50 % [5]. There are special recommendations which are common for seeds storage of plant genetic resources accessions in genbanks [6]. In reality, in practical grasses breeding seed storage is not always in accordance with these standards, but researches on optimal seed storage conditions were carried out for seeds with a view to extending seed longevity.

The level of *Agropyron cristatum* seed viability during storage for 20 years under different conditions was investigated. It was found that an important factor was the temperature. So, when samples were stored at 21°C, 5°C, 1°C, – 7°C and minus 18°C, the last two temperatures ensured the seeds germanation at the level of 80 – 90% for 20 – 30 years. Seed drying, even for 6.5 hours at 60°C, also given advantages in the longevity of the investigated seed samples compared to those stored without additional drying at a moisture content 8 %. Plastic or glass closed containers had advantages over paper bags [7].

Post-harvest changes of *Dactylis glomerata* seeds of populations from different origins were observed. It has been established that faster overcome of post-harvest seed dormancy was under normal natural storage conditions, in the light, than in cool and dry conditions, for example 15°C, 15 % RH. *Dactylis glomerata* seed germination was different depending on the origin of the population. Processes in the *Dactylis glomerata* seeds after harvesting can be inhibited when the seeds are found at – 75°C [8].

The research on bagged seed storage of *Agropyron cristatum*, hair fescue (*Festuca filiformis* Pourr.), meadow brome (*Bromopsis riparia* (Rehm.) Holub.), intermediate wheatgrass (*Elytrigia intermedia* (Host) Nevsky), *Roegneria trachycaulon* was carried on in a typical depository. It is established that the seed longevity period on the average was: 50 months for *Elytrigia. intermedia*, 47 for *Festuca filiformis*, 37 – *Bromopsis riparia*, 35 – *Agropyron cristatum*, 33 – *Roegneria trachycaulon*. It should be noted that the *E. intermedia* and *Festuca filiformis* seed protein content was the lowest and accounted for 14.9 % and 13.5 % respectively.

The starch content was the highest and accounted for 36.9 % and 32.1 %, respectively. For the rest samples, the seed protein content was 17.1, 16.5, 16.9 % respectively; and starch content 30.0, 28.6, 26.1 %. The idea about seed hygroscopicity was discussed under connection between chemical composition of the seeds (protein, fats, starch content) and different experimental samples longevity what leads to different activity of biochemical processes during storage [9].

Endophytic flora affects seed longevity during storage. This influence may be negative and positive [10]. So, there are well-known invesigations of the importance of endophytic flora, such as *Neotyphodium*, it longevity in the storage of *Festuca* and *Lolium* seeds. These studies confirm the importance of special storage conditions not only for the seed longevity, but also for its endophytic flora [11]. It is known that the viability of endophytes for 4 – 8 years seed storage is reduced to 5 % and below [12].

Viability, after ripening period fluctuations of *Festuca filiformis, Elytrigia intermedia, Bromopsis riparia, Agropyron cristatum, Roegneria trachycaulon* depending on the environmental conditions were noted. The authors cite the data that the seeds of the studied species did not lose laboratory germinability during storage under uncontrolled conditions since 24 months (*Roegneria trachycaulon*) to 52 (*Festuca filiformis* and *Elytrigia intermedia*) [13].

The investigations results of seeds harvesting terms influence on seed quality and seed yield of the plants grown from the grasses seeds are known. The harvesting terms of *Festuca filiformi*, colonial bent grass (*Agrostis capillaris* L.), *Festuca rubra* with aim to improve seed quality through the study of the peculiarities of seed formation have been investigated. It was found that the highest yields of these crops at seed moisture content 30 and 35 % were harvested. At moisture content more than 35 % an unthreshed seed rate and at moisture content less than 30 % seed abscission was observed, which a reason was of yield decrease. Laboratory germination and seed growth power depended on harvest time and moisture content of seeds, in particular, they decreased by 1 – 10 % when the seeds were harvested at optimum terms under for moisture content above 40 % and below 20 % [14].

The goal of this work was to determine the optimal conditions for grasses seed storage under controlled conditions at different temperatures and low seed moisture content, to monitor the dependence availability of seed longevity from the reproduction site of seeds.

MATERIALS, METHODS AND CONDITIONS

The material for research were seeds of 86 accessions of fodder grasses from the National Plant Genetic Accessions Depository of Ukraine: 23 *Bromopsis inermis* accessions; 13 *Dactylis glomerat* accessions; 10 *Phleum pretense* and *Agropyron cristatum* accessions; six – *Lolium multiflorum*; five – *Lolium perenne*; three – *Festuca rubra, Festuca pratensis, Roegneria trachycaulon*; two – *Agrostis alba, Agrostis gigantean*; one – *Festuca gigantea, Festuca amethystina, Festuca arundinacea, Agropyron desertorum.*

The seeds were grown in the institutions of the System of Plant Genetic Resources of Ukraine: Carpathian region Institute of Agriculture of NAAS (CRIA), Precarpathians; Institute of feed and agriculture of Podillia of NAAS (IFAP), right-bank forest-steppe of Ukraine; Institute of Agriculture of NAAS (IA), northern right-bank forest-steppe of Ukraine; Ustymivka Experimental Station of Plant Production of Plant Production Institute nd. a. V. Ya. Yuriev of NAAS (UESPP), Poltava State Agricultural Experimental Station n.a. N. I. Vavilov of Institute of Pig Production and Agro-Industrial Production of NAAS (PSAES) forest-steppe of Ukraine; Institute of Irrigated Agriculture of NAAS (IIA), steppe of Ukraine.

Climatic conditions were characterized by hydrothermal coefficient (HTC) [15]. HTC indexes for CRIA, IFAP, IA, PSAES, IIA are presented on Fig.1, for UESPP – on Fig.2. The average index HTC during summer months was mainly due to excessive humidity (HTC =1.6 – 2) for CRIA, for IA – HTC was about 1 during the investigation year (normal conditions), for IFAP either arid (HTC =0.6 – 1) or excessive humidity (HTC =1.6 – 2), for PSAES – mostly (HTC = 0.6 – 1). For UESPP– varied from 0.7 to 1.6.

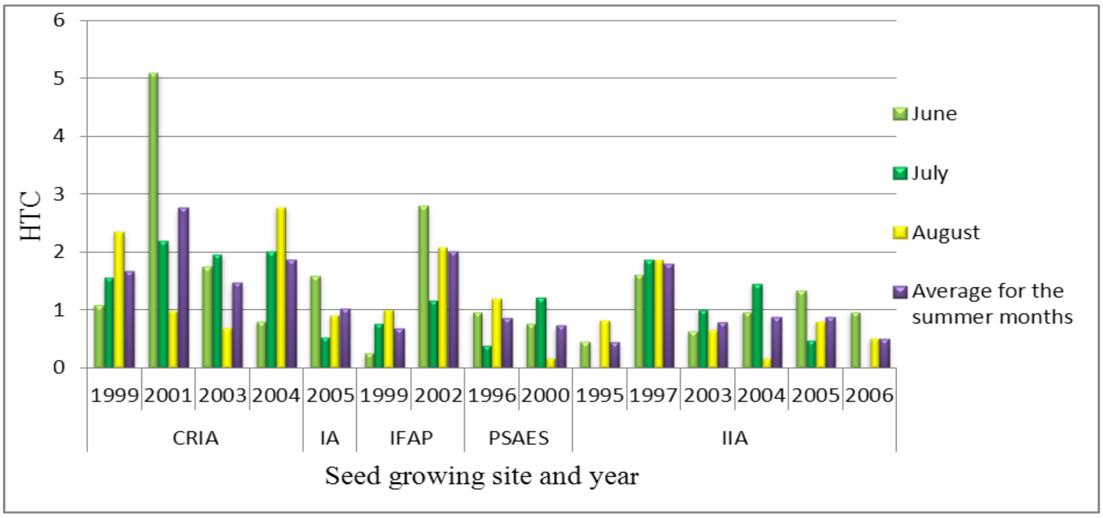

Fig.1. **HTC for June, July, August, an average for summer months in diferent sites of seed growing.**

1995 – 2004 seeds reproduction were investigated. Accessions came from Ukraine (53), Russia (11), Canada (9), Belarus (2) and one sample from Norway, Lithuania, Poland, USA, Tajikistan, Hungary, Czech Republic. Among the investigated accessionces, 22 belonged to wild species, 21 to commercial varieties, 4 to breeding forms, and 4 to local forms.

Before laying, the seeds were initially dried by airflow at a temperature not higher than 25°C and a relative humidity of 25 % using a Munters drying agent (Sweden) to a moisture content of 3.4 – 6.0 %. After that, the seeds were placed in a sealed container.

Seed samples were stored in three blocks of storage: in a block with unregulated temperature (ut), a block with a temperature of 4°C, a block with a temperature of –20°C. The vast majority of acessions were stored at 4°C. Storage of the accessions was started in 1996 and continues to this day. The average temperature in the storage block with unregulated temperature was 9°C at oscillation in the range from –18°C to –25°C. Most of the samples laid in the uncontrolled temperature storage block after at first. After NCPGRU was equiped by the block with negative temperature unit seed were transferred to this block.

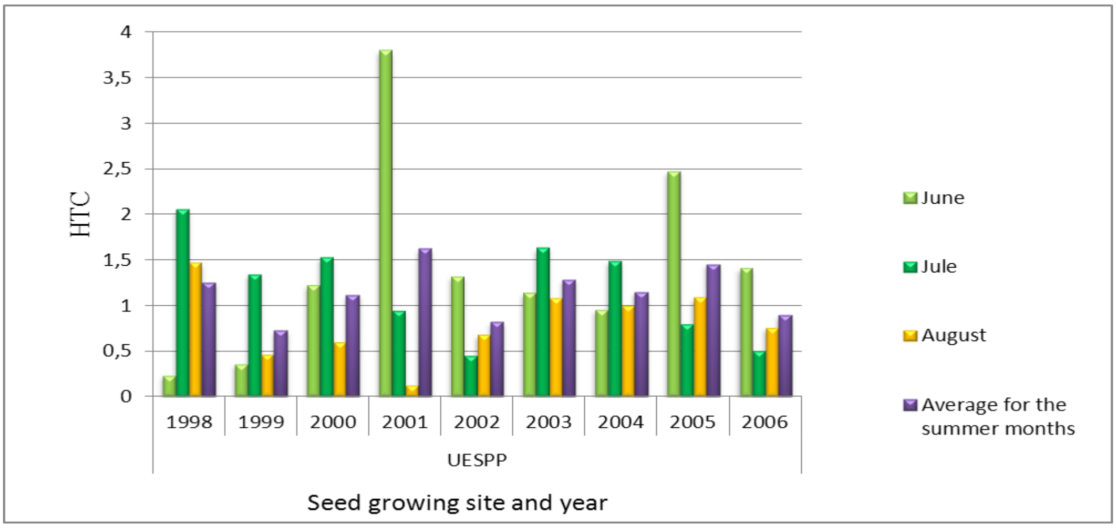

Fig.2. **UESPP HTC for June, July, August, an average for summer months.**

In order to determine the seed germination before and control during storage appropriate methods were used that seed laing between filter paper sheets at a variable temperature 20 – 30°C with illumination [16, 17]. Periodic viability monitoring was conducted on average every 5 years. The results were processed using methods of variation statistics [18]. The criterion of the sample particles was used to compare two samples.

RESULTS AND DISCUSSION

The results of the conducted studies indicate a high longevity of *Phleum pretense* seeds under controlled conditions (Fig. 3). The seeds were stored at 4°C, except accessions Vyshhorodska, Arhenta, Sarnetska 35, UJ1100061, which were originally stored in a block with unregulated temperature, and after 10 years of storage was transferred to a storage block with –20°C temperature.

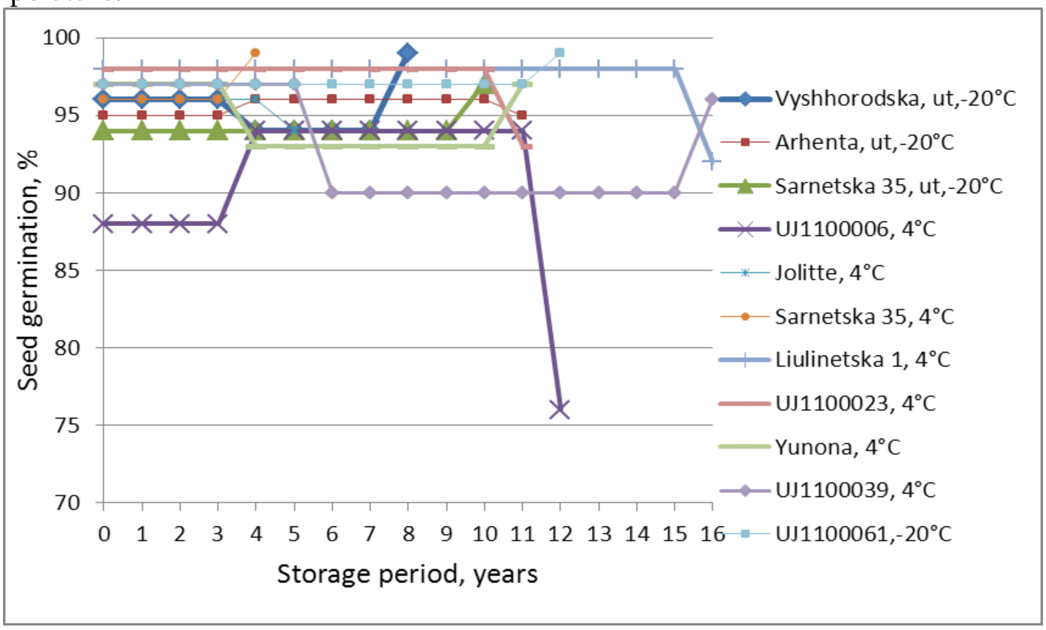

Fig.3. ***Phleum pretense*** **seed germination after storage with moisture content 4 – 6 %, 2000 – 2016.**

The accession UJ1100061 was stored at –20°C. The results demonstrate the advantage of *Phleum pretense* seed storage at a negative temperature although after storage at 4°C seed germination was also at a high level and almost did not differ significantly from the baseline for most samples ($p<0.05$). UJ1100006 germination after 12 years of storage at a temperature of 4°C was decreased by 12 % ($p>0.05$), despite the seed moisture content of the storage was 3.8 %. Perhaps such a significant decrease is due to the conditions of accession reproduction. This accession reproduced at the UESPP in 2001, and this year has HTC over the summer period exceeded 1.6. Consequently, the seeds ripening was under high humidity.

Dactylis glomerata seed storage was in block with unregulated temperature for 10 – 20 years led to a significant germination decrease after 10 years of storage for two accessions (Fig. 4).

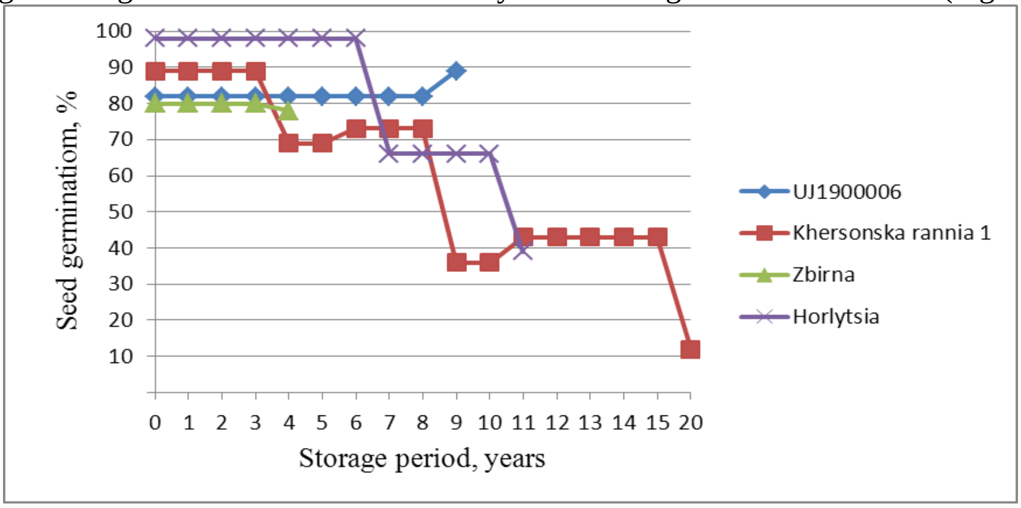

Fig.4. ***Dactylis glomerata*** **seed germination after storage at unregulated temperature, moisture content 4 – 6 %, 2000 – 2016.**

The 1999 summer months HTC for Horlytsia variety grown in the CRIA was 1.6, indicating the wet conditions for seed maturation. The HTC heavesting conditions for other accessions, in particular UJ1900006, grown in 1998 in the UESPP, was less (Fig. 2) and amounted to 1.25 on average over the summer. The HTC summer months of the IIA for the Khersonska rannia 1 variety in 1995 was 0.44, indicating the arid conditions of the reproduction year (Fig. 1). The obtained results testify to the negative influence of dry conditions of growing seeds on its longevity. *Dactylis glomerata* seeds storage at a temperature of 4°C shown a significant germinatioin decrease for most accessions: Drohobychanka (ICHKR), Rybiny / WL (UESPP), Muravka (IA), Oleshka 14 (CRIA), D.Ukraina (IFAP, 2005) by more than 10 % after 4 – 10 years (Fig. 5).

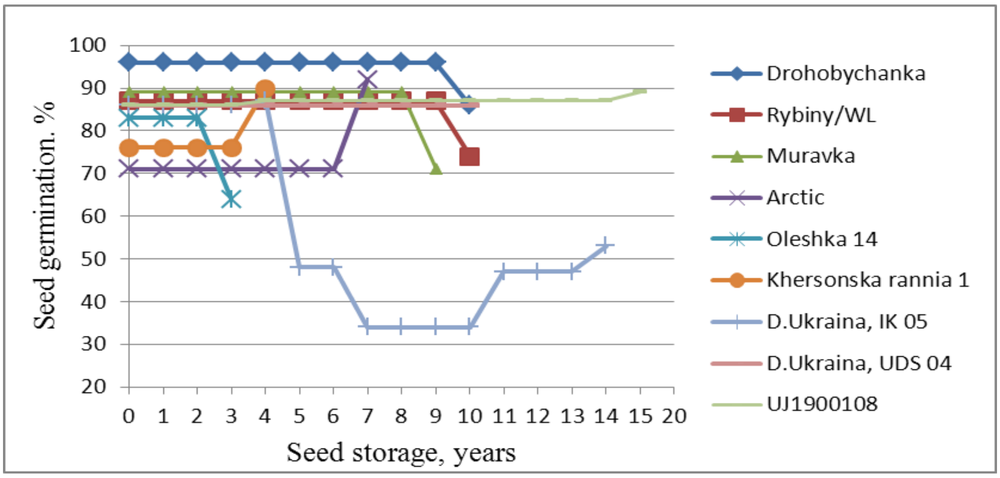

Fig.5. ***Dactylis glomerata*** **seed germination with moisture content 4 – 6 % after storage at 4°C, moisture content 4 – 6 %, 1996 – 2016.**

We believe that this is a consequence of genotype characteristics of the seeds of this crop in comparison, for example, with *Phleum pretense*. 2002 accessions: Khersonska rannia 1 (UESPP) which ripened under the condition HTC 0.82, Arctic (IFAP) – under the condition of HTC 2.07 did not decrease the germination for 4 – 8 years of storage at 4°C. *Dactylis glomerata* seed storage indicates a positive effect of these conditions to preserve the seed germination for most accessions at 20°C (Fig. 6).

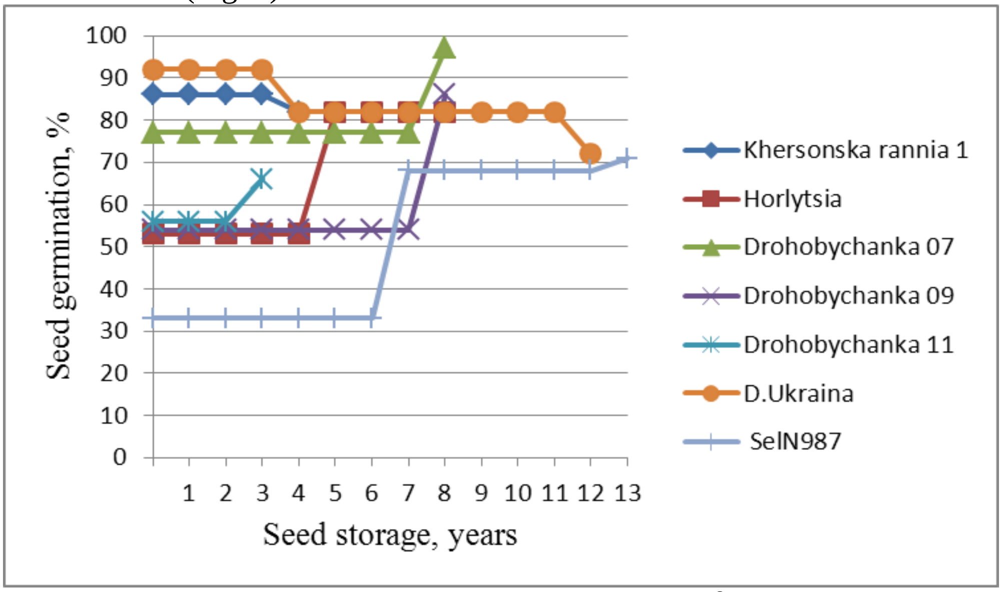

Fig.6. ***Dactylis glomerata*** **seed germination after storage at –20°C, moisture content 4 – 6 %, 2000 – 2012.**

Such accessions as Khersonska rannia 1 (IIA) and D.Ukraina (IFAP) in 2005, there was a significant germination decrease compared with the initial Only (p>0.05). It should be noted that the conditions of this year reproduction in both the IIA and the IFAP were arid (Fig. 1). Seed germination increase results for the rest of the accessions which are stored at – 20°C are complemented by similar monitoring results under these conditions for other crops and can be explained by changes in the balance of phytohormones [18–20]. Seeds of the Drohobychanka of different reproduction years (2007, 2009, 2011) CRIA showed different absolute indices, but a similar tendency in the dynamics of seed germination after storage under these conditions.

Bromopsis inermis seed storage for 3 – 9 years in a block with unregulated temperature induced significant seed germination decrease of C 586, Poltavskyi 5 (p>0.05) (Fig. 7).

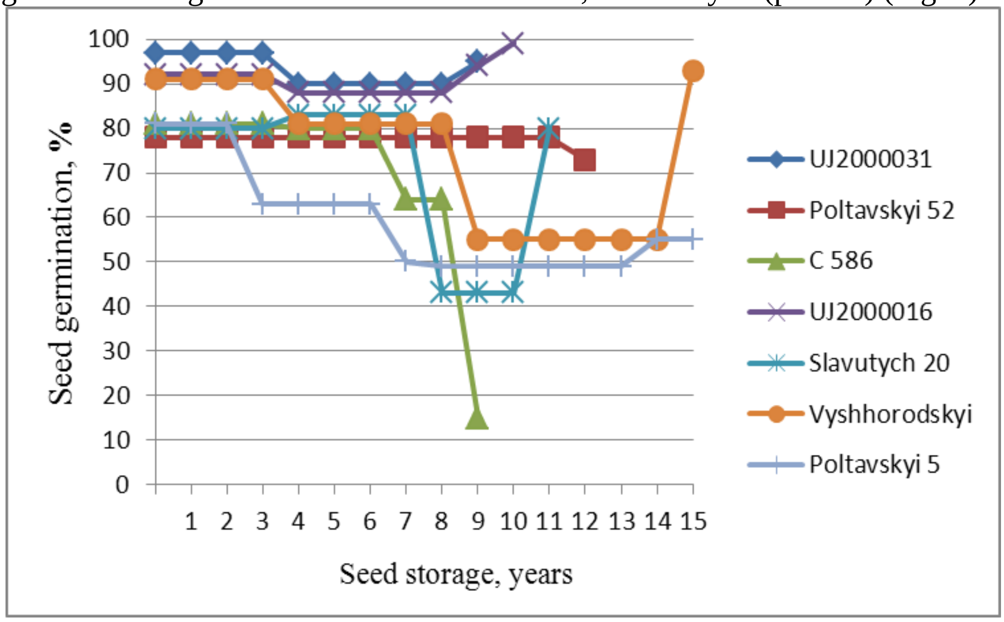

Fig.7. ***Bromopsis inermis*** **seed germination after storage at unregulated temperature, moisture content 4 – 6 %, 2000 – 2012.**

It should be noted seed germination of Slavutych 20, Vyshhorodskyi after their transfer to – 20°C storage block was increased by almost 40 %. UJ2000016 seed germination was increased by 7 % after 10 years of storage under unregulated conditions, but under the influence of negative temperatures in the winter. This phenomenon confirms the presence of a positive effect of negative temperature on *Dactylis glomerata* seed germination. UJ2000031, Poltavskyi 52 germination after storage in the block with unregulated temperature, remained unchanged. There was a tendency of seed germination decreasing for Tavryiskyi 1 (IIA, 2003) UJ2000035 (UESPP, 2002), Prychornomorskyi 2 (CRIA, 2004), UJ2000119 (CRIA, 2003) after *Dactylis glomerata* seed storage for 4 – 7 years at 4°C (Fig. 8).

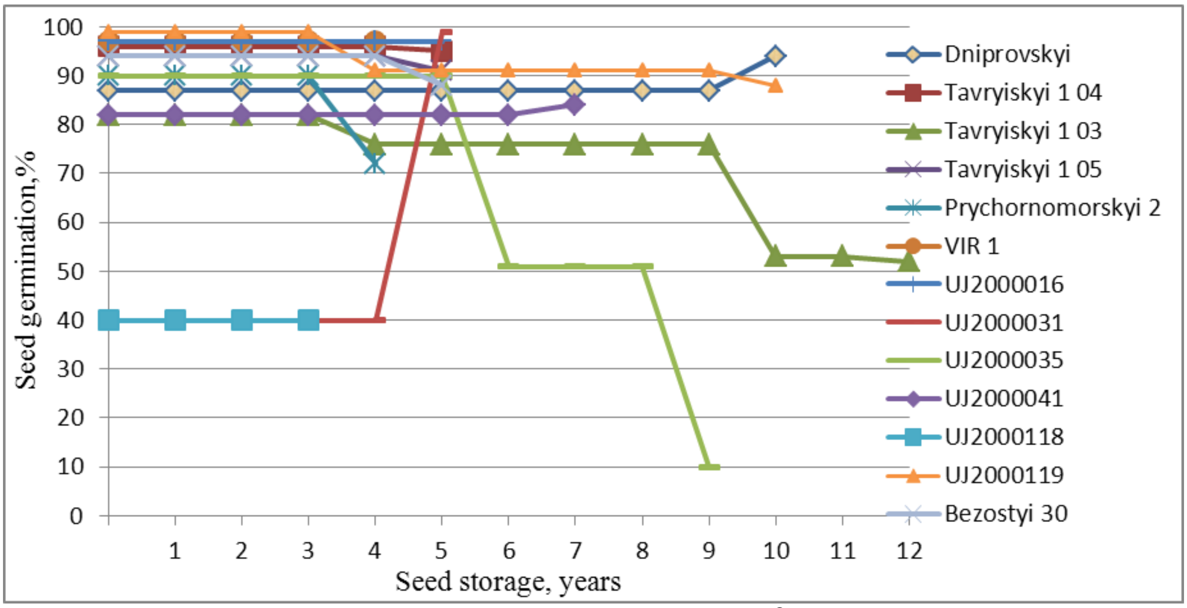

Fig.8. ***Bromopsis inermis*** **seed germination after storage at 4°C, moisture content 4 – 6 %, 2000 – 2016.**

The obtained results indicate that the seed longevity depended on the meteorological conditions of seed ripening and on the accession genotype. There was a germination increase, which may be explained by post-harvest maturing for the accession UJ2000031 (IFAP, 2002). Such germination increase after storage is described for other crops also [19–21]. This is probably due to changes in the content of seed phytohormones, which are subject to change under the influence of low positive and negative temperatures. *Bromopsis inermis* seed storage at –20 C for 10 years didn't induce significant changes Poltavskyi (UESPP, 2006), C 752 (UESPP, 2006), C 1479-1485 (IIA, 2006) ($p<0.05$) (Fig. 9).

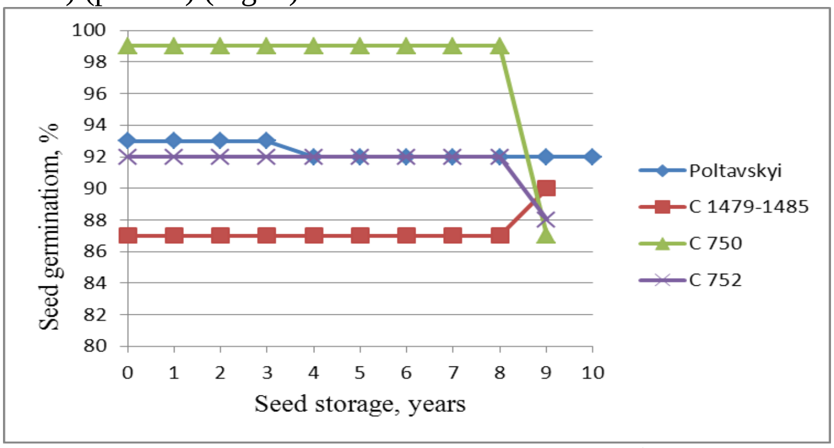

Fig.9. ***Bromopsis inermis*** **seed germination after storage at – 20°C, moisture content 4 – 6 %, 2000 – 2016.**

C750 seed germination (UESPP, 2006) decreased significantly after nine years of storage. Perhaps this is due to unfavorable conditions of seed maturation, since the UESPP HTC in 2006 was 0.5 (Fig. 1), which indicates the arid July. These conditions affected the same way on seeds of another germplasm accession C 752. The studies have shown the importance for the most genotypes *Bromopsis inermis* seeds storage at – 20°C to prolong it longevity.

A similar conclusion can be done on the analysis of *Bromopsis riparia* seed storage. For 10 years accession storage at 4°C there was a tendency to decrease seed germination of UJ2000044 (IFAP, 2004) by 2 %, or a significant decrease for UJ2000044 (UESPP, 2004) by 14 %. There were observed germination increase by 8 % – from 91 to 99 % ($p>0.05$), or no change for accessions UJ2000122, UJ2000192 (2005, 2005) at – 20°C.

There was no significant seed germination decrease of *Agropyron cristatum* stored at negative temperature for nine years in comparison with the initial one – 91 % for UJ1200065 (UESPP, 2006) (Fig. 10). The seed germination of UJ1200011 (UESPP, 1999) when stored under uncontrolled conditions initially increased by 9 % ($p>0.05$), and then decreased by 25 % ($p>0.05$).

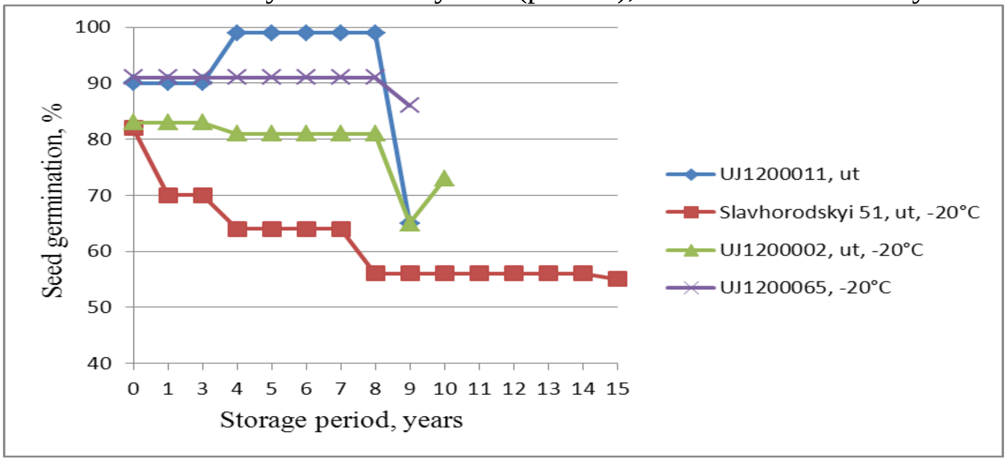

Fig.10. ***Agropyron cristatum*** **seed germination at unregulated temperature, –20°C, 1999 – 2016.**

In the remaining accessions, seed germination gradually decreased during initial storage under uncontrolled conditions. Even the accessions transfer in 4 – 9 years to the block with the negative temperature did not stop this process for Slavhorodskyi 51 (UESPP, 2000) (after four years of storage) and increased the resemblance to 8 % in the local form UJ1200002 (UESPP, 1998 .) Thus, it is important *Agropyron cristatum* seeds at the negative temperature storage from the very beginning of long-term storage.

There was no significant germination decrease for the most *Agropyron cristatum* accessions stored for 10 years at temperature 4° C (Fig. 11). It was noted germination decrease by 11 % after 10 years of storage for UJ1200060 only (IFAP, 2002), ($p>0.05$).

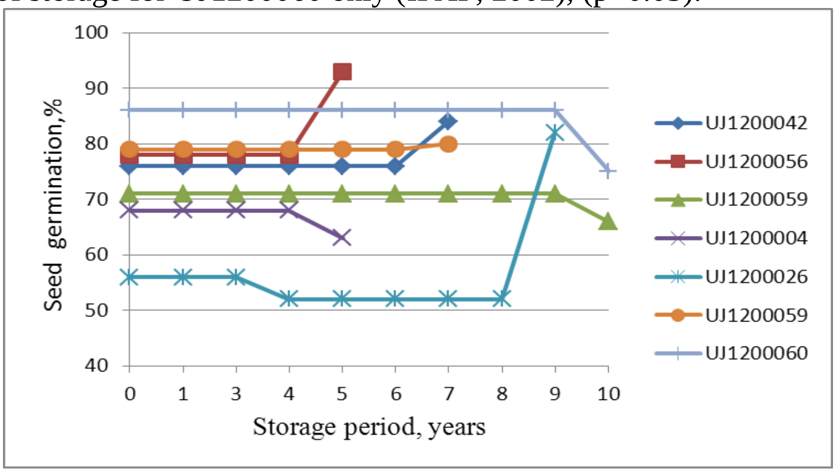

Fig.11. ***Agropyron cristatum*** **seed germination after storage at 4°C, moisture content 4 – 6 %, 1999 – 2016.**

UJ1200042 (UESPP, 2002) tended to germination increase, and for UJ1200026, UJ1200056 (UESPP, 2001, 2001, 2004), the increase was by 26 % and 15 % respectively (p>0,05). Thus, at low positive temperatures, *Agropyron cristatum* seed germination is remained at the constant level. For individual accessions the increase is possible, which was observed for other ones.

Festuca rubra seed storage at unregulated temperature has induced seed germination decrease for UJ1300001 by 40 % (p>0.05) after five years of storage (Fig. 12).

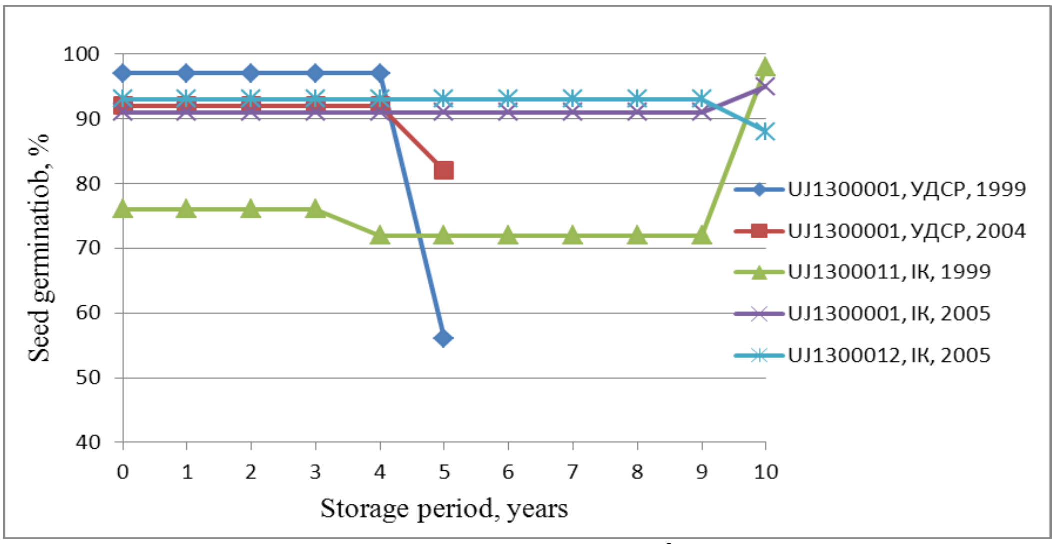

Fig.12. ***Festuca rubra*** **seed germination after storage at 4°C, moisture content 4 – 6 %, 1999 – 2016.**

This can be consequence as high level of seed moisture content during the seed growing in UESPP (Fig. 2), as well as the unfavorable conditions of storage temperature. When stored at low positive (UJ1300001, UJ1300011) and negative (UJ1300001, UJ1300012) temperatures, the initial germination above 90 % remained unchanged. Initial seed germination of UJ1300011 76 % has increased by 22 % after 20 years of storage (p>0.05).

It is observed seed germination increase of *Festuca pratensis* by 8 % (p> 0.05) after seed storage for five years at 4°C. Two other accessions of *Festuca rubra* UJ1300005 and UJ1300007 were stored at unregulated temperature at first. After eight years of seed storage at moisture content about 5 % their initial germination did not significantly change and was 73 and 88 % respectively. After seed transferring from unregulated temperature to the negative temperature chamber, a significant seed germination increase by 18 % (p>0.05) or 6 % (p <0.05) was observed. Thus, *Festuca pratensis* seeds under used conditions can be stored for more than 10 years without germination changing. *Festuca gigantea* and *Festuca amethystina* initial germination (88 % and 95 % respectively) hasn't not changed after storage at 4°C for at least five and seventeen years respectively. Initial germination 88 % of *Festuca arundinacea* didn't changed after storage for 10 years at – 20°C. There is a decrease of *Lolium perenne* seed germination after seed storage for 4 – 10 years at 4°C and under uncontrolled temperature (Fig. 13).

Drohobytskyi 19 (IA, 2001) and Inka (UESPP, 2001) seed germination was reduced by 8 % (p> 0.05) and 2 % (p <0,05) respectively at storage temperature 4°C for four years. After 12 years of storage under such conditions, the germination of experimental accessions was decreased by 52% and 23%, respectively. Seed storage at unregulated temperature for four years of LR 95 (IA, 1999), Drohobytskyi 16 (CRIA, 1999) and the wild form UJ1400012 (UESPP, 2000) shown a tendency of germination decrease for accessions LR 95, UJ1400012 (p<0.05) and for Drohobytskyi 16 by 21% (p> 0.05). Further there was a seed germination decrease. Seed transfer to the block with a temperature – 20°C and it storage for six years resulted to germination increase by 5% for UJ1400012 and LR 95.

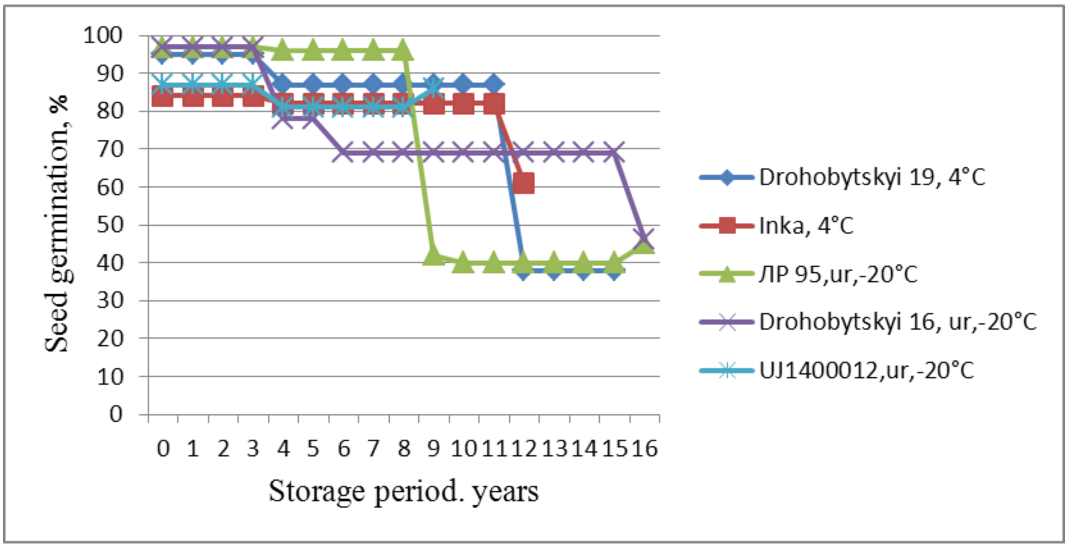

Fig.13. ***Lolium perenne*** **seed germination after storage at different temperature, moisture content 4 – 6 %, 1999 – 2016.**

After six years of storage at –20°C, a further germination decrease for Drohobytskyi 16 to 46 % was determined. There was either no change or further germination decrease observed for further storage at a negative temperature. Further studies should be conducted to determine the optimal storage conditions for this species. We believe that for long-term *Lolium perenne* seed storage at the negative temperature should be recommended.

Lolium multiflorum seed storage at 4°C did not affect the seed germination after seven years of storage in Yaroslav-02 (IFAP, 2002), UJ1400202 (CRIA, 2004) and caused seed germination by16 % for the Kyivskyi variety (UESPP, 2002) and a slight decrease in Rosavii (UESPP, 2004) (Fig. 14).

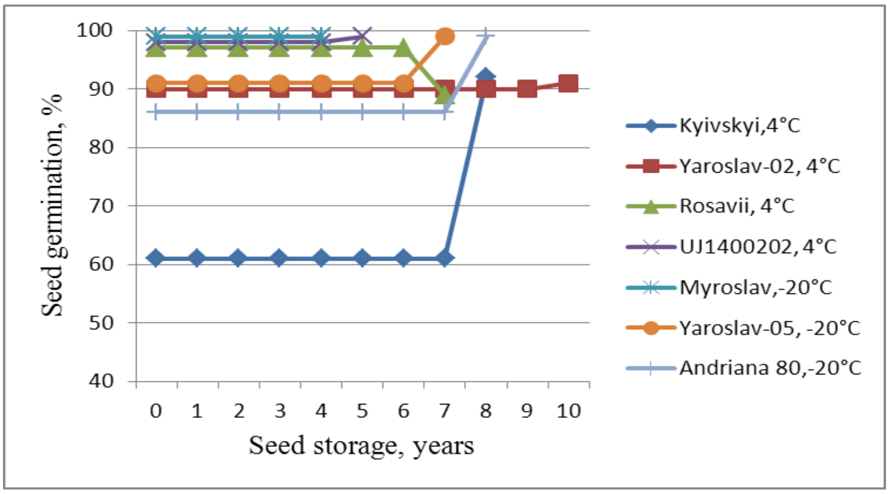

Fig.14. ***Lolium multiflorum*** **seed germination after storage at 4 C, moisture content 4 – 5 %, 2000 – 2016.**

Seed storage at –20°C did not cause changes of Myroslav (IIA, 2005) seed germination and led to seed germination increase of Yaroslav-05 (IFAP, 2002), Andriana 80 (IA, 2005). Thus, the applied storage regimes can be recommended for *Lolium multiflorum* long-term storage, especially at the negative temperature.

Arrhenatherum elatius seed storage at 4°C for eight years caused germination increase from 73 to 98 % ($p>0.05$) in Sopron variety. Drongo seed storage (IFAP, 2009 p.) at the negative temperature for six years caused germination decrease from 59 to 40 % ($p>0.05$). UJ1500001 seed storage at unregulated temperature (UESPP, 1999) caused germination decrease from 98 to 68 %

also (p>0.05). Subsequent sample transfer to a negative temperature chamber resulted to germination increase by 25 % after four storage years (p>0.05). Owing to *Arrhenatherum elatius* seed germination variation at different storage temperatures it is necessary to carry on supplemental investigation for optimizing seed storage regimes.

Roegneria trachycaulon seed germination after seed storage at 4°C for seven years is increased by 3 % of J1600003 (p <0.05), by 30 % of Chief (p>0.05) (IFAP, 2002) and decreased by 10 % of Adanac (UESPP, 2002) (p>0.05). It should be noted that all accessions were 2002 year of reproduction, the first two accessions had a moisture content 4.3 %, and Adanac – 2.9 %. In order to find out the effect of the reproduction site and seed moisture content on the seed longevity it is necessary to carry out supplemental investigation of the storage especialities *Roegneria trachycaulon* seeds.

Agrostis alba seed storage at 4°C, caused seed germination decreasing for UJ3200008 by 4 % (p <0.05) and by 15 % for Halychanka (UESPP, 2002) (p>0.05). The Halychanka (CRIA, 1999) seeds germination has been increased from 94 to 8 % (p>0.05) after storage at unregulated temperature for seven years. Further storage at –20°C for nine years didn't change seed germination and remained at the level of 83 %.

Agrostis gigantea seed germination of Guoda (IFAP, 2009) after six storage years at –20°C was increased from 40 to 96 % (p>0.05). It can be assumed that the seeds of this species should be kept at negative temperature.

The results of the conducted studies show different grasses seed longevity, even under similar storage conditions. It can be assumed that this is coused by the epecialities of the reproduction conditions and the genotype of seed accessions.

CONCLUSIONS

Thus, studies have shown that *Phleum pretense*, *Agropyron cristatum, Agropyron desertorum, Lolium multiflorum, Lolium perenne, Festuca rubra, Festuca pratensis, Festuca gigantea, Festuca amethystina, Festuca arundinacea, Arrhenatherum elatius, Roegneria trachycaulon, Agrostis alba, Agrostis gigantea* seeds have different longevity at different storage temperatures under genebank conditions. Seed accessions storage under uncontrolled temperature even for 5 years, caused gradual seed germination decrease. *Phleum pretense, Dactylis glomerata Agropyron cristatum, Lolium multiflorum* and some *Festuca rubra* seed accessions are allowed to store without germination changing at 4°C for at least five years. The best results on the grass seed longevity are achieved under storage at –20°C. Seed longevity of different forage grasses may vary depending on the conditions of seeds growing, in particular, the temperature and humidity conditions during seed ripening. However, the optimal seed reproduction site to extend seed longevity among studied cultivation sites located in Precarpathians, steppe and forest steppe zones has not been established.

REFERENCES

1. Konyk H. S., Ivantsiv R. Ye., Harmych D. Yu. Perennial grasses breeding in Precarpathians. Kormy i kormovyrobnytstvo. 2016. Vyp. 82. C.15–20.
2. Tanaka T., Tamaki H., Ashikaga K., Fujii H., Tamura K., Yamada T. Use of SSR Markers to Increase Forage Yield in Timoty (*Phleum pratense* L.). In: Budak H., Spangenberg G. .2015. (eds) Molecular Breeding of Forage and Turf. Springer, Cham .[Електронний ресурс]: Режим доступу: http: //confer.uiesr.sops.gov.ua
3. Kölliker R, Boller B, Widmer F (2005) Marker assisted polycross breeding to increase diversity and yield in perennial ryegrass (*Lolium perenne* L.). Euphytica 146:55–65.
4. DSTU 8518:2015, Fodder crops. Seeds of perennial grasses (meadow fescue, Timothy grass, Kentucky bluegrass). Growing technology. General requirements.
5. Khoroshailov NG, Zhukova NV. The experience of long-term seed storage. Trudy po prikladnoi botanike, genetike i selektsii. 1973; 49(3): 269–279.

6. FAO. 2015. Gene bank standards for plant genetic resources for food production and agriculture. The 2nd revised and expanded edition. Rome. 182 p.
7. Ackigoz E., Knowles R. P. Long-term storage of grass seeds. Can. J. Plant Sci. 1983.63:669-674.
8. Probert R. J., Smiths R. D.,Birch P. Germination responses to light andalternating temperatures in european populations of *Dactylis glomerata* L. New Phytol. (1985) 101, Issue 3. 521-529.
9. Buhaiov V. V. The chemical composition and physical and mechanical seed properties of cereals perennial grasses, as a factor of their longevity. Selektsiia i nasinnytstvo. 2016. Vyp. 109. C.131–139.
10. Gundel P.E., Hamilton C.E., Seal C.E., Helander M. Martinez-Ghersa M. A., Ghersa C.M., Vazquez de Aldana B.R., Zabalgogeazcoa I., Saikkonen K. Antioxidants in Festuca rubra L. seeds affected by the fungal symbiont Epichloe festucae. Symbiosis. 2012. 58:73–80.
11. Hume D.E., Card S.D., Rolston M.P. Effects of storage conditions on endophyte and seed viability in pasture grasses2013 Proceedings of the 22nd International Grassland Congressю 405–408.
12. Kirkby K.A., Pratley J.E., Hume D.E., Min An. Viability of seed and endophyte (*Neotyphodium occultans*) in annual ryegrass (*Lolium rigidum*) when buried and in long term storage . Seed Science and Technology. 2011. 39(2):452-464.
13. Buhaiov V. V. Influence of biological characteristics of some perennial grasses species on seed viability and longevity. Kormy i kormovyrobnytstvo. 2014. Vyp. 78. C.8-12.
14. Vasylenko N. Ye., Antoniv S. F., Kolisnyk S. I., Konovalchuk V. V., Zapruta O. A., Fostolovych S. I., Klochaniuk A. V. Influence of harvest time on seed yield and viability of grass seeds. Kormy i kormovyrobnytstvo. 2018. Vyp. 85. 33-40.
15. Sielianinov G. T. Agroclimatic world map. Л.: Leningrad, 1966. 12 c.
16. DSTU 4138-2002. Crop seeds. Methods of quality determination. К.: Derzhpozhyvstandart Ukrainy; 2003: 173 p.
17. International rules for seed testing. M.:Kolos; 1984: 311 p.
18. Volf VG. Statistical processing of experimental data. M: Kolos; 1966. 255 p.
19. Linnik YuO, Riabchun VK, Boguslavskyi RL. Utility model patent "Method of Improvement of Crop Seeds Viability by Freezing". Plant Production Insitute nd. a V.Ya. Yuriev UAAS. No 50130; filing date 12.07.2009; publ. date 05.25.2010.
20. Zadorozhna O. A. Herasimov M. V., Shyianova T. P. Seed longevity under ontrolled conditions. Zbirnyk naukovykh prats PDATU. 2016. VYP.24. Ch.1. P.77-86.
21. Zadorozhna O. A. Herasimov M. V., Shyianova T. P. Bread wheat seed storage under controlled conditions. Henetychni Resursy Roslyn. 2016; 19: 118–131.

СПИСОК ЛІТЕРАТУРИ

1. Коник Г. С., Іванців Р. Є., Гармич Д. Ю. Селекція багаторічних злакових трав у Передкарпатті. Корми і кормовиробництво. 2016. Bun. 82. С.15-20.
2. Tanaka T., Tamaki H., Ashikaga K., Fujii H., Tamura K., Yamada T. Use of SSR Markers to Increase Forage Yield in Timoty (*Phleum pratense* L.). In: Budak H., Spangenberg G. .2015. (eds) Molecular Breeding of Forage and Turf. Springer, Cham .[Електронний ресурс]: Режим доступу: http: //confer.uiesr.sops.gov.ua
3. Kölliker R, Boller B, Widmer F (2005) Marker assisted polycross breeding to increase diversity and yield in perennial ryegrass (*Lolium perenne* L.). Euphytica 146:55–65
4. ДСТУ 8518:2015, Кормові культури. Насіння багаторічних злакових трав (костриця лучна, тимофіївка лучна, тонконіг лучний). Технологія вирощування. Загальні вимоги.
5. Хорошайлов Н.Г., Жукова Н.В. Длительное хранение коллекционных образцов семян. Труды по прикладной ботанике, генетике и селекции. 1973. Т.49. Вып.3. С.269-279.
6. ФАО. Стандарты генных банков для генетических ресурсов растений для производства продовольствия и ведения сельского хозяйства. Издание второе, исправленное и дополненное. Рим. 2015. 182с.
7. Ackigoz E., Knowles R. P. Long-term storage of grass seeds. Can. J. Plant Sci. 1983.63:669-674.

8. Probert R. J., Smiths R. D.,Birch P. Germination responses to light andalternating temperatures in european populations of *Dactylis glomerata* L. *New Phytol.* (1985) 101, Issue 3. 521-529
9. Бугайов В. В. Хімічний склад та фізико–механічні властивості насіння злакових багаторічних трав, як чинник його довговічності. Селекція і насінництво. 2016. Випуск 109. С.131-139
10. Gundel P.E..Hamilton C.E., Seal C.E., Helander M. Martinez-Ghersa M. A., Ghersa C.M., Vazquez de Aldana B.R., Zabalgogeazcoa I., Saikkonen K. Antioxidants in Festuca rubra L. seeds affected by the fungal symbiont Epichloe festucae. Symbiosis. 2012. 58:73–80
11. Hume D.E., Card S.D., Rolston M.P. Effects of storage conditions on endophyte and seed viability in pasture grasses2013 Proceedings of the 22nd International Grassland Congressю 405–408.
12. Kirkby K.A., Pratley J.E., Hume D.E., Min An. Viability of seed and endophyte (*Neotyphodium occultans*) in annual ryegrass (*Lolium rigidum*) when buried and in long term storage . Seed Science and Technology. 2011. 39(2):452-464.
13. .Бугайов В. В. Вплив біологічних особливостей деяких видів багаторічних злакових трав на життєздатність та довговічність насіння Корми і кормовиробництво. 2014. Вип. 78. С.8-12.
14. Василенко Н. Є., Антонів С. Ф., Колісник С. І., Коновальчук В. В., Запрута О. А., Фостолович С. І., Клочанюк А. В. Вплив строків збирання на насіннєву продуктивність та посівні якості насіння низових злакових трав. Корми і кормовиробництво. 2018. Вип. 85. 33-40.
15. Селянинов Г. Т. Агроклиматическая карта мира. Л.: Ленинград, 1966. 12 с.
16. .ДСТУ 4138-2002. Насіння сільськогосподарських культур. Методи визначення якості. К.: ДержпоживстандартУкраїни, 2003. 173 с.
17. Международные правила анализа семян. М.: Колос, 1984. 311с.
18. Вольф В.Г. Статистическая обработка опытных данных. М: Колос, 1966. 255с.
19. Лінник Ю. О., Рябчун В. К., Богуславський Р. Л. Пат. на корисну модель «Спосіб підвищення життєздатності насіння сільськогосподарських культур шляхом заморожування» / ; Ін.-т рослинництва ім. В. Я. Юр’єва УААН. № 50130; дата подання заявки 07.12.2009 ; опубл. 25.05.2010.
20. Задорожная О. А., Герасимов Н. В., Шиянова Т. П. Довговічність насіння гречки в контрольованих умовах. Збірник наукових праць ПДАТУ. 2016. Вип.24. Ч.1. С.77-86.
21. Задорожная О. А., Герасимов Н. В., Шиянова Т. П. Хранение семян пшеницы мягкой в контролируемых условиях. Генетичні ресурси рослин. 2016. №19. С. 118-131.

Задорожна О. А., Герасимов М. В., Шиянова Т. П.
Інститут рослинництва ім. В. Я. Юр'єва НААН
Національний центр генетичних ресурсів рослин України
Московський пр. 142, Харків, 61060, Україна
E-mail: olzador@ukr.net

ЗБЕРІГАННЯ НАСІННЯ ЗЛАКОВИХ ТРАВ В УМОВАХ ГЕНБАНКУ

Метою даної роботи було виявити оптимальні умови зберігання насіння злакових трав у контрольованих умовах, з’ясувати можливості його зберігання за різних температур та низької вологості насіння, відстежити наявність залежності довговічності насіння від місця репродукції насіння.

Результати та їх обговорення. Досліджена життєздатність насіння 86 зразків кормових злакових трав: стоколосу безостого (*Bromopsis inermis* (Leyss.) Holub.), грястиці збірної (*Dactylis glomerata* L.), тимофіївки лучної (*Phleum pretense* L.), житняку гребінчастого (*Agropyron cristatum* (L.) *Gaertn*.), житняку пустельного (*A. desertorum* (Fisch. ex Link) Schult. et Scult.f.), пажитниці багатоквіткової (*Lolium multiflorum* Lam.), пажитниці багаторічної (*L. perenne* L.), костриці червоної *(Festuca rubra* L.), костриці лучної (*F. pratensis* Huds.), костриці велетенської (*F. gigantea* (L.) Vill.), костриці безостої (*F. inarmata* Schur.), костриці очеретяної (*F. arundinacea* Schreb.), райграсу високого (*Arrhenatherum elatius* (L.) P. Beauv. ex J. S. et K. B. Presl.), регнерії шорсткостеблової

(*Roegneria trachycaulon* (Link) Nevski), мітлиці білої (*Agrostis alba* L.*), м*ітлиці велетенської (*A. gigantea* Roth.), що зберігались у контрольованих температурних умовах за вологості 3 – 6 %. Встановлено, що насіння цих видів має різну довговічність за різних температур зберігання в умовах генбанку. Для тимофіївки лучної, грястиці збірної, житняку гребінчастого, пажитниці багатоквіткової, окремих зразків костриці червоної допускається зберігання насіння без зміни схожості за температури 4 ^{o}C до 10 років і довше. Обговорюються особливості зберігання насіння окремих видів.

Висновки. Найкращу довговічність насіння злакових трав досягнуто при його зберіганні насіння за температури мінус 20^{o}C. Довговічність насіння різних кормових трав може різнитись у залежності від умов вирощування насіння, зокрема температури і вологості умов його дозрівання. Проте не встановлено оптимального місця репродукування насіння для подовження його довговічності серед вивчених місць вирощування, розташованих у Передкарпатті, зонах степу й лісостепу.

Ключові слова: *злакові трави, насіння, генофонд, зберігання, довговічність, температура, вологість, схожість.*

Задорожная О. А., Герасимов М. В., Шиянова Т. П.
Институт растениеводства им. В. Я. Юрьева НААН
Национальный центр генетических ресурсов растений Украины
Московский пр. 142, Харьков, 61060, Украина
E-mail: olzador@ukr.net

ХРАНЕНИЕ СЕМЯН ЗЛАКОВЫХ ТРАВ В УСЛОВИЯХ ГЕНБАНКА

Целью данной работы было выявить оптимальные условия хранения семян злаковых трав в контролируемых условиях, выяснить возможности их хранения при различных температурах и низкой влажности семян, отследить наличие зависимости долговечности семян от места их репродукции.

Результаты и их обсуждение. Исследована жизнеспособность семян 86 образцов кормовых злаковых трав: костреца безостого (*Bromopsis inermis* (Leyss.) Holub.), ежи сборной (*Dactylis glomerata* L.), тимофеевки луговой (*Phleum pretense* L.), житняка гребенчатого (*Agropyron cristatum* (L.) Gaertn .), житняка пустынного (*Agropyron desertorum* (Fisch. ex Link) Schult. et Scult.f.), райграса многоцветкового (*Lolium multiflorum* Lam.), райграса многолетнего (*Lolium perenne* L.), овсяницы красной (*Festuca rubra* L.), овсяницы луговой (*Festuca* pratensis Huds.), овсяницы гигантской (*Festuca* gigantea (L.) Vill.), овсяницы безостой (*Festuca* inarmata Schur. (*Festuca amethystina* (Hack. ex Boiss.) St.-Yves)), овсяницы тростниковой (*Festuca* arundinacea Schreb.), райграса высокого (*Arrhenatherum elatius* (L.) P. Beauv. ex JS et K. B. Presl.), пырея бескорневищного (*Roegneria trachycaulon* (Link.) Nevski), полевицы белой (*Agrostis alba* L.), полевицы гигантской (*Agrostis gigantea* Roth.), которые хранились в контролируемых температурных условиях при влажности 3 – 6 %. Установлено, что семена этих видов имеет разную долговечность при различных температурах хранения в условиях генбанка. Для тимофеевки луговой, ежи сборной, житняка гребенчатого, райграса многоцветкового, отдельных образцов овсяницы красной допускается хранение семян без изменения сходства при температуре 4°C до 10 лет и дольше. Обсуждаются особенности хранения семян отдельных видов.

Выводы. Лучшую долговечность семян злаковых трав достигнута при их хранении при температуре –20^{o}C. Долговечность семян различных кормовых трав может различаться в зависимости от условий выращивания семян, в частности температуры и влажности условий их созревания. Однако не установлено оптимальное место репродуции семян для увеличения их долговечности среди изученных мест выращивания, расположенных в Прикарпатье, зонах степи и лесостепи.

Ключевые слова: *злаковые травы, семена, генофонд, хранение, долговечность, температура, влажность, всхожесть.*