RESEARCH ARTICLE (Open Access)

Germinability and seedling vigor of some *Aegilops* accessions seeds at different level of aging

VJOLLCA IBRO[1]*, ANXHELA KALOSHI[1], ENKELEDA COKA[1]

[1]Department of Plant Sciences and Technologies, Faculty of Agriculture and Environment, Agricultural University of Tirana, AUT

*Corresponding author; E-mail: vibro@ubt.edu.al

Abstract

The genus *Aegilops* is very rich in accessions that can be used for the improvement of wheat breeding, especially in creating wheat lines or synthetic hexaploid wheat with high resistance to abiotic stresses and diseases. The reported viability of different *Aegilops* seeds is 2-6 years. This study provides insight into the morphological and physiological relationships among some germination and growth traits on 10 *Aegilops* accessions after various periods of seed storage 2, 3 and 4 years. Seed germination was characterized by a standard germination test, based on the 1 mm root protrusion and the development of normal seedlings. Germinability was determined by counting the number of germinated seeds in a container (after 24 h and 96 h), whereas the seedling growth ability was calculated as the mean length of the first leafs emerging from germinated seeds. The spikes weight, dry and imbibed seeds weight for each *Aegilops* accession have been evaluated. Beside these, the seeds imbibitions potential and seedlings height, dry weight, first leaf length and dry weight, specific leaf weight, have been evaluated, too. This study provides that after 4 years of seeds storage their germinability decreased for all *Aegilops* accessions taken in consideration. The germination rate was very low (30-70 % after 24 h of seeds exposure to humidity and less than 80% after 96 h). Significant differences were found for seedlings growth. Seeds aging retarded the time of seedlings emerge and reduced their height, fresh and dry weights, the first leaves mean length and their dry weight too.

Keywords: *Aegilops* seeds, seeds aging, seedling early growth, seedling vigor

1. Introduction

Efficient strategy to solve loss of plant diversity consists of exploiting wild germoplasm genomes of species, which preserve a good part of their adaptive factor and diseases tolerance. The genera *Aegilops* and *Triticum* (wild and cultivated wheat) are taxonomically placed in the tribe *Triticeae* of the *Poaceae*. The value of wild wheat relatives as a genetic resource for wheat cultivars improvement depends on the amount of genetic variability. The genus *Aegilops* contains 22 species comprising both diploids and polyploids, which originated from the center of origin [7, 18, 20]. The study of genetic diversity of the genetic resources of *Aegilops* may provide significant information regarding their potential for wheat breeding. Types of *Aegilops* that are closely related to wheat, exhibit greater genetic diversity, the exploitation of which has been the subject of experimentation for many years [9)] This refers to the ability to make classical taxonomic studies, cytological and evolutionary studies, as well as the application of the methods chromosomal and genetic engineering in cultivated forms, in order to inclusion ones as many desirable features [8]. *Aegilops* as relative to the cultivated wheat have many genes of agronomic interest and they can be important sources for resistance to disease, pests and extreme environmental factors. Plant seeds lose their viability when they are exposed to long term storage or controlled deterioration treatments, by a process known as seed aging. The reported viability of different *Aegilops* seeds is 2-6 years. Seed aging is a crucial issue for plants with economic importance, and also for wild plants, like *Aegilops* used for restoration or germplasm conservation. Long time storage generally reduces seed viability and vigor. Deterioration is evident as a reduction in percentage germination, loss of vigor, produce weak seedlings, become less viable and eventually seed death [17]. The rate of deterioration varies among species and environmental conditions. It was reported that reduced leaf area and seedling dry weight may be due to the indirect and direct effects of seed aging. The indirect effect influenced on seedling growth by delayed emergence. The effects of seed aging can gradually improve after early seedling growth [15]. Moreover, the fraction of seed reserve mobilization decreases with aging duration [6, 11, 10]. Several former studies aimed to find out if the *Aegilops* accessions collected in different parts of Albania show any variability regarding their spikes, seeds and seedlings different traits [3]. The objective of recent study was to identify the change of their seeds germinability and seedling early growth components in response to different periods of seeds storage (aging).

2. Materials and Methods

The plant material consists in 10 *Aegilops* accessions collected in different regions of Albania during the expeditions performed as part of a biodiversity identification and conservation project [14]. The collection is planted every year since 2009 in separate plots in AUT Botanical Garden.

Table 1. The *Aegilops* accessions named according the regions where are collected.

No.	Accession	No.	Accession
1	Ardenica 5	5	Borsh 5/4
3	Pojan 5/2	9	Tërpan 5/8
4	Patos 5/3	10	Tomorr 5/9
6	Lukovë 5/5	15	Barmash 227
24	Priskë 165	20	Shushicë El. 160

The present study was conducted to evaluate the effect of seed aging (seed quality) on germination, emergence and seedling growth of 10 different *Aegilops* accessions. The comparison of germinability and seedlings vigor of different *Aegilops* accessions seeds at different levels of aging was the main objective of the study. Forty spikes from each of 10 different *Aegilops* accessions for every party of spikes storaged for 4, 3 and 2 years weighted. Thirty seeds for each of them have been moistened with distilled water in Petri dishes (10 cm diameter).The experimental probe was established at room conditions, in Crop Physiology Laboratory, AUT. Seed germination was characterized by a standard germination test, based on the 1 mm root protrusion and the development of normal seedlings. Germinating seeds were counted every day until no further germination was observed. Germinability was determined by counting the number of germinated seeds in container (after 24 h and 96 h), whereas the seedling growth ability was calculated as the mean length of the first leaf emerging from germinated seeds. The spikes weight, the dry and imbibed seeds weight for each *Aegilops* accession have been evaluated. Beside these, the seeds imbibitions potential and seedlings height, dry weight, first leaf length and dry weight and specific leaf weight, have been evaluated, too. The experimental design was two factors arranged in a completely randomized design with three replicates. The first factor was accessions and the second was aging duration (4, 3, 2 years). Two Way Analysis of Variance (Normality Test Shapiro-Wilk and Equal Variance Test, Brown-Forsythe). are performed for all parameters measured and the coefficients of correlations among different traits are evaluated, too.

Figure 1. Views from the work with *Aegilops* accessions at AUT " Xhaferr Qosja" Botanical Garden and the Laboratory of Crop Physiology

3. Results and Discussion

3.1. The aging influence on Aegilops spikes weight

The spikes weights of 10 different *Aegilops* accessions showed significant differences among accessions, but not among three different periods of storage (aging).

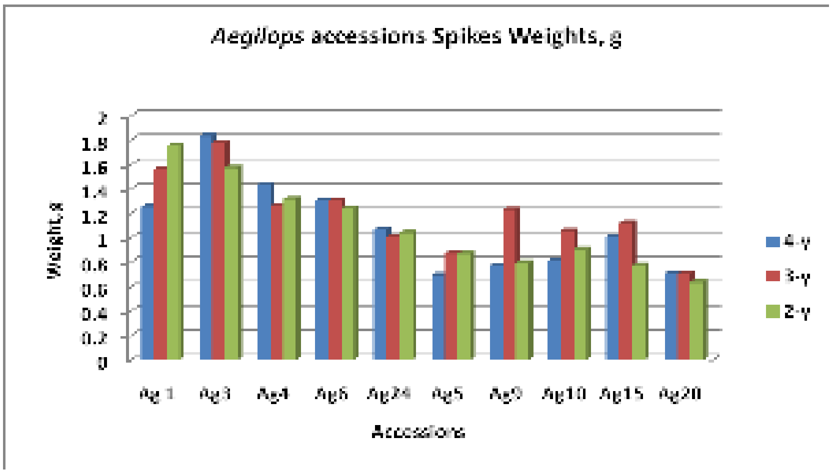

Figure 2. The weights of spikes from ten different *Aegilops* accessions storaged for 4, 3 and 2 years

Table 2. The results of two ways analysis of variance for the weights of 4, 3 and 2 years storage spikes from ten different *Aegilops* accessions.

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Accessions	2.9795	9	0.331056	**16.26368**	6.39E-07	2.456281
Aging	0.066313	2	0.033157	**1.628871**	0.223768	3.554557
Error	0.366399	18	0.020356			
Total	3.412213	29				

The above results show that different storage periods do not influence significantly on *Aegilops* spikes weights. On the other side the spikes weights show important differences among 10 *Aegilops* accessions. This is in conformity with results reported earlier (4).

3.2 The influence of seed aging on different Aegilops accessions seeds germinability

Seed size (dry seed weight) can be considered as an indicator of seed quality (2). The data processing show that imbibed seeds weights correlate positively with their dry weights for all *Aegilops* accessions evaluated (see Table 3.) But it is important to underline that the imbibitions (imbibed seeds weights as % of dry seeds weights after water absorption) was significantly greater for small seeds like them of cylindrical ears accessions (Fig.3 accessions 5, 9, 10, 15, 20). These results show the same trend with earlier results (5).

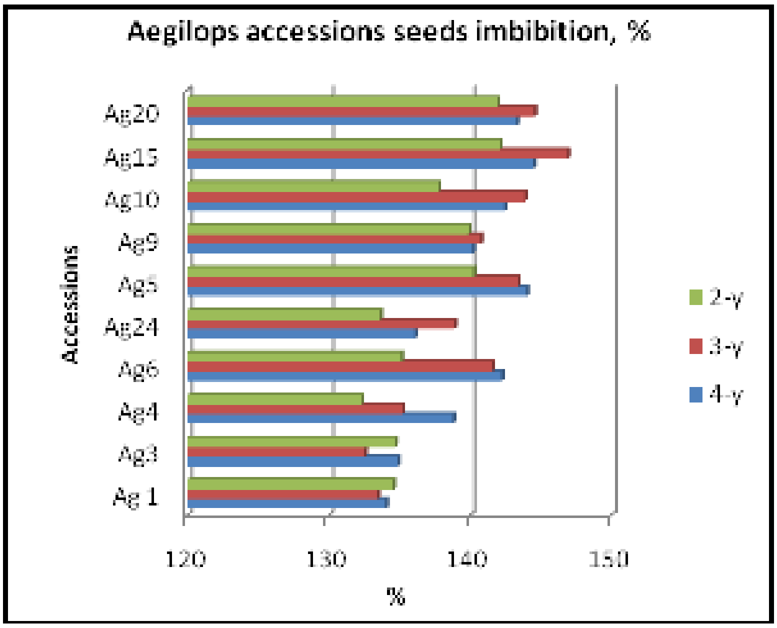

Figure 3. Imbibitions of different *Aegilops* accessions seeds at different levels of aging; 2, 3 and 4 years

Table 3. The values of Coefficients of Correlation among different germinability traits.

	SDW	ISW	Imbib.	GV	GP
SDW	1				
ISW	**0.995773**	1			
Imbib.	**-0.59713**	**-0.53413**	1		
GV	0.290086	0.276009	-0.16854	1	
GP	0.290215	0.276932	-0.16242	**0.696632**	1

The two ways analysis of variance showed that the difference in the mean values among the different accessions is greater than would be expected by chance after allowing for effects of differences in aging. There is a statistically significant difference (P = <0.001).

The difference in the mean values among the different levels of aging is not great enough to exclude the possibility that the difference is just due to random sampling variability after allowing for the effects of differences in accessions. There is not a statistically significant difference (P = 0.141).

The effect of different accessions does not depend on what level of aging is present. There is not a statistically significant interaction between accession and aging. (P = 0.989). (See Table 4. for more details).

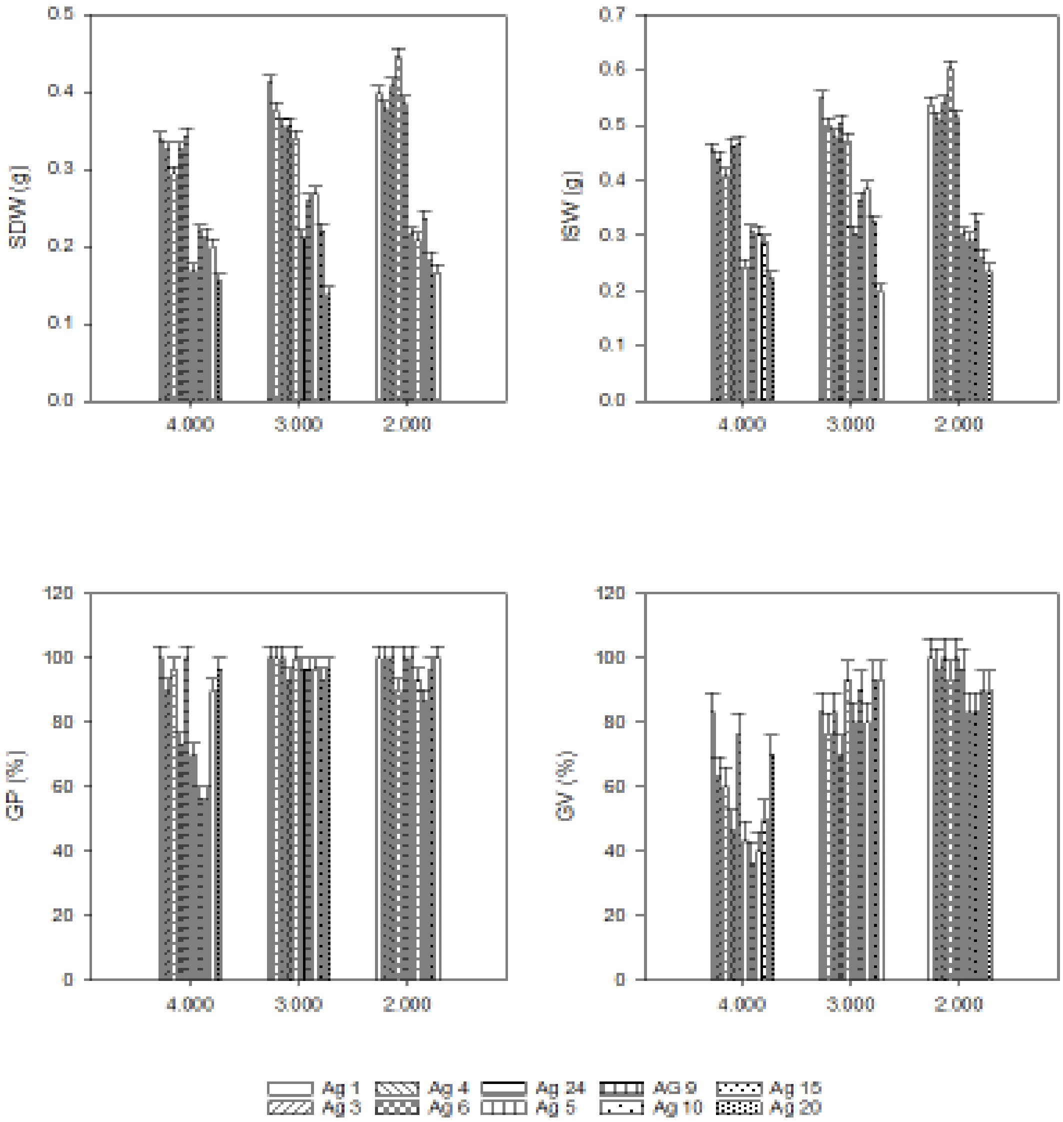

Figure 4. Germinability different traits of ten *Aegilops* accessions seeds after three storage periods 4, 3, 2 years: ten seeds dry weight (SDW), ten imbibed seeds weight (ISW), % of germinated seeds in first 24 hours (GV), % of germinated seeds after 96 hours

The effect of seeds aging on their germinability (% of germinated seeds in first 24 h and % of germination after 96 h) is greater for *Aegilops* accessions 9, 10 (less than 60%) and 6, 5 (less than 80%). *Aegilops* accessions 1, 24, 20 do not show any significant difference in germination among seeds storage for 2, 3 and 4 years.
The Table 4 contains the results of two ways analysis of variance performed for each seed germinability trait evaluated; seed dry weight (SDW), imbibed seed weight (ISW), % of seed germination after 24 h (GV) and % of seeds germination after 96 h (GP). The two way analysis of variance showed that the difference in the mean values of germinability traits (DSW, ISW, GV and GP) among the different accessions is greater than would be expected by chance after allowing for effects of differences in aging. There is a statistically significant difference (P = <0.001). On the other side, the effect of aging on germination is very significant, especially on GV and GP.

Table 4. The results of Two Ways Analysis of Variance of 10 Aegilops accessions seeds germinability traits.

		SDW	ISW	Imbib	GV	GP
	SS	0.632	1.042	1286.559	5115.556	4698.889
	MS	0.0702	0.116	142.951	568.395	522.099
Accession	**F**	**236.480**	**224.412**	**4.902**	**5.065**	**13.425**
	P	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**
	SS	0.0335	0.0521	118.055	21482.222	3926.667
	MS	0.0167	0.026	59.027	10741.111	1963.333
Seed aging	**F**	**56.308**	**50.47**	**2.024**	**95.713**	**50.486**
	P	**<0.001**	**<0.001**	**0.141**	**<0.001**	**<0.001**
	SS	0.0440	0.0688	193.292	4784.444	4251.111
Acc X age	MS	0.00245	0.00382	10.738	265.802	236.173
	F	**8.236**	**7.408**	**0.368**	**2.369**	**6.073**
	P	**<0.001**	**<0.001**	**0.989**	**0.007**	**<0.001**

The effect of different accession on germinability depends on what level of aging is present. There is a statistically significant interaction between accession and aging (P = <0.001) for SDW, ISW and GP.

3.3. The vigor of seedlings originated from Aegilops seeds at different level of aging

Seedling establishment and emergence rate are reduced with increase in seed storage duration (19). Seedling growth rate is closely related to the germination. The seedlings growth characteristics are important for determining seedlings vigor. The Table 5 contains the results of two ways analysis of variance performed for each seedling growth trait evaluated; first leaf length (FLL), seedling height (SdH), first leaf dry weight (FLDW) seedling dry weight (SdDW). The two ways analysis of variance showed that the difference in the mean values of seedling vigor traits SdH, FLDP and SdDW among considered *Aegilops* accessions is greater than would be expected by chance after allowing for effects of differences in their seeds aging. On the other side, the effect of aging is very significant on each of four traits of seedling growth. It is proved by statistically significant difference (P = <0.001) for each of them. FLL is affected more from different periods of seeds aging than from different accessions. Low seed quality may be followed by undesirable germination and lead to low vigor seedlings, especially under stressful conditions (1, 13,15, 16).

Table 5. The results of Two Way Analysis of Variance for some traits of seedlings originated from seeds at different level of aging, 2, 3 and 4 years.

		FLL	SdH	FLDW	SdDW
	SS	20.017	170.687	28.033	2203.864
	MS	2.224	18.965	3.115	244.874
Accession	F	2.925	11.186	15.279	119.259
	P	**0.006**	**<0.001**	**<0.001**	**<0.001**
	SS	53.006	71.98	13.187	210.332
	MS	26.503	35.99	6.593	105.166

Seed age	F	34.861	21.228	32.342	51.218
	P	**<0.001**	**<0.001**	**<0.001**	**<0.001**
	SS	32.366	106.061	7.94	200.515
Acc X age	MS	1.798	5.892	0.441	11.14
	F	2.365	3.475	2.164	5.425
	P	0.007	**<0.001**	0.014	**<0.001**

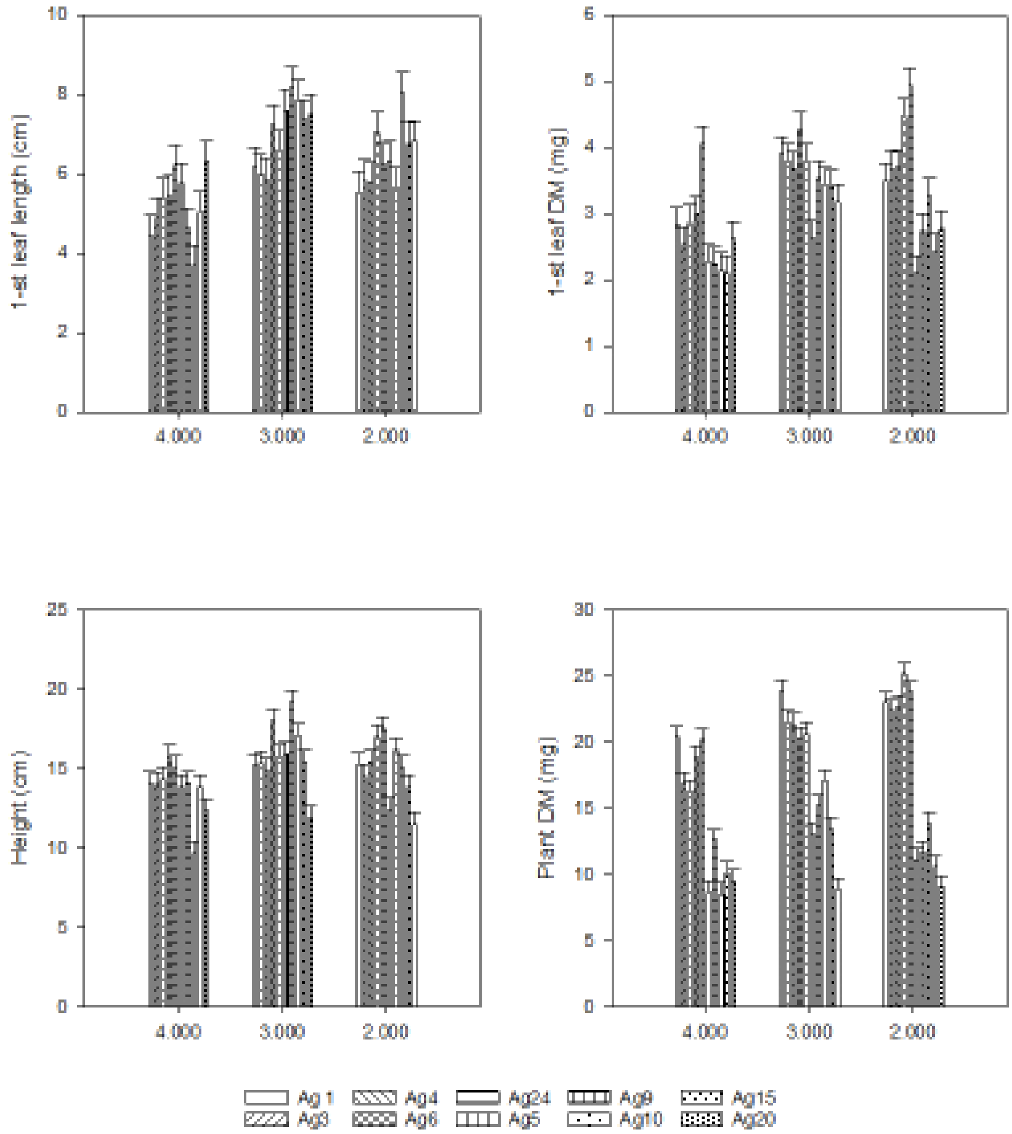

Figure 5. Five weeks seedlings growth characteristics of ten different *Aegilops* accessions originated from seeds with different level of aging; 2, 3 and 4 years. The evaluated traits include 1-st leaf length (FLL), first leaf dry weight (FLDW), seedling height (SdH) and plant dry matter (SdDW)

Related the influence of seeds aging on different seedling traits, the data show that the most affected accession for seedling height (SdH) and first leaf length (FLL) is *Aegilops* accession 10. The less affected ones are accessions 20 and 24.

Table 6. The values of Coefficients of Correlation among different seedling growth traits.

	FLL	SdH	FLDW	SdDW
FLL	1			
SdH	**0.507229**	1		
FLDW	0.396319	**0.596185**	1	
SdDW	-0.03227	**0.507861**	**0.738531**	1

The results of correlative analysis among different traits of *Aegilops* accessions seedling growth show that exist positive strong relations among first leaf length (FLL) and first leaf dry weight (FLDW) and other traits (seedling height, seedling dry weight).

4. Conclusions

This study provides that after 4 years of seeds storage their germinability decreased for all *Aegilops* accessions taken in consideration. The germination rate was very low (30-70 % after 24 h of seeds exposure to humidity and less than 80% after 96 h). The effect of seeds aging on their germinability (% of germinated seeds in first 24 h and % of germination after 96 h) is greater for *Aegilops* accessions 9, 10 (less than 60%) and 6, 5 (less than 80%). *Aegilops* accessions 1, 24, 20 do not show any significant difference in germination among seeds storage for 2, 3 and 4 years. Significant differences were found for seedlings growth. Seeds aging retarded the time of seedlings emerge and reduced their height, fresh and dry weights, the first leaves mean length and their dry weight too. Related the influence of seeds aging on different seedling traits, the data show that the most affected accession for seedling height (SdH) and first leaf length (FLL) is *Aegilops* accession 10. The less affected ones are accessions 20 and 24.

5. Acknowledgement

We are very grateful to Mr. Bashkim Grifsha at Botanical Garden “ Xhaferr Qosja”, AUT for his permanent support in the different stages of the experimental probes on the Aegilops accessions collection.

6. References

1. De Figueiredo E, Albuquerque MC, De Carvalho NM: **Effect of the type of environmental stress on the emergence of sunflower (Helianthusannus L.), soybean (Glycine max L.) and maize (Zea mays L.) seeds with different levels of vigor**. Seed Sci. Technol 2003, **31**: 465-479.
2. Ellis RH: **Seed and seedling vigour in relation to crop growth and yield**. Plant Growth Regul.1992, **11**: 249-255.
3. Ibro V, Salillari A, Suna R, Grifsha B**: A comparative study of some *Aegilops* collected at different regions of Albania**. Natura Montenegrina. No.9, 2010. ISSN1451-5776.
4. Ibro V. et al.: **The study of ear characteristics of some *Aegilops* accessions collected in Albanian territory.** 3rd International Conference of Ecosystems (ICE 2013), Tirana, Albania. The Proceedings Book ICE; 2013.
5. Ibro V, Prebibaj M, Axhani A**: Seed seedling relations in two very distinct Aegilops accessions**. Albanian j.agric. sci. 2017 p.51-58
6. Kapoor N, Arya A, Siddiqui MA, Kumar H, Amir A: **Physiological and biochemical changes during seed deterioration in aged seeds of rice (*Oryza sativa* L.**) Amer. J. Plant Physiol. 2011, **6**:28–35.
7. Kimber G, Feldman M.: **Wild wheat**. An introduction. University of Missouri-Columbia.1987.

8. Lange W & Jochemsen G: **Use of the gene pools of *Triticum turgidum* ssp. *dicoccoides* and *Aegilops squarossa L.* for the breeding of common wheat (*Triticum asetivum*) through chromosome doubled hybrids.** 2. Euphytica 1992b, **59**: 213-220.
9. Maxted N, Kell SP**.: Establishment of a Network for the In situ Conservation of Crop Wild Relatives: Status and Needs**. Food and Agriculture Organization of the United Nations. 2009.
10. McDonald MB: **Seed deterioration: Physiology, repair and assessment**. Seed Sci. Technol. 1999, **27**:177–237.
11. Mohammadi H, Soltani A, Sadeghipour HR, Zeinali E.: **Effects of seed aging on subsequent seed reserve utilization and seedling growth in soybean**. Intl. J. Plant Production 2011, **5**: 65–70.
12. Nik SMM, Tilebeni HG, Zeinali E, Tavassoli A: **Effects of seed ageing on heterotrophic seedling growth in cotton.** American-Eurasian J. Agr. Environ. Sci. 2011, **10**: 653–657.
13. Rehman S,. Harris PJC, Bourne WF.: **Effect of artificial ageing on the germination, ion leakage and salinity tolerance of *Acacia tortilis* and *A. coriacea* seeds**. Seed Sci. Technol. 1999, **27**: 141-149.
14. Salillari A. et al.: **Resurset gjenetike**. Tiranë. 2007.
15. Soltani ES, Galeshi B, Akramghaderi K, Akramghaderi F.: **Modeling seed aging effects on the response of germination to temperature in wheat.** Seed Sci. Biotech. 2008, **2**: 32-36.
16. Tekrony DM, Egli DB: **Relationship of seed vigor to crop yield: A review**. Crop Sci. 1991, 31: 816-822.
17. Tilebeni G, Golpayegani H.: **Effect of seed ageing on physiological and biochemical changes in rice seed (Oryza sativa L.).** International Journal of AgriScience, 2011, **1**(3), 138-143.
18. Van Slageren MW.: **Wild Wheats: a monograph of *Aegilops* L. and *Amblypyrum* (Jaub. and Spach) Eig (Poaceae)**. Wageningen Agricultural University, Netherlands. 1994.
19. Verma SS, Verma U, Tomer RPS: **Studies on seed quality parameters in deteriorating seeds in Brassica (*Brassica campestris*)**. Seed Sci. Technol. 2003, **31**: 389-396.
20. Zhang XY, Wang RRC, Dong YS: RAPD **polymorphisms in *Aegilops geniculata* Roth (*A. ovata* auct. non L.)**. Genetic Resources and Crop Evolution 1996, **43**: 429–433.