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Functional Diagnostics and Genetic Prognosis Models of Seed Viability and Longevity

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These studies aimed creation of universal models suitable for plants belonging to various taxonomic groups, and enabling to give functional diagnostics and genetic prognosis of viability potentials and longevity of their seed samples. In the example of plants belonging to diverse taxonomic groups, new approach is proposed for functional diagnostics of viability potential of seeds and their longevity in individual samples and for making genetic prognosis. Based on this, universal practical models with high decisive capacity have been elaborated and quality factors have been worked out.

Keywords: *genebank, genetic forecast, plant genetic resources, ex situ conservation, germination, pattern, seed viability*

INTRODUCTION

One of pressing issues in conservation of biodiversity includes purposeful collection of genetic resources of plants and organization and maintenance of an ensure reliable conservation of collected materials. Among biodiversity conservation strategies the method of *ex situ* conservation has the special importance. *Ex situ* conservation mainly considers maintenance of plant seeds in special condition (genebank). But seeds as well as other biological objects grow old and lose their viability. Longevity of plants, including their seeds is one of principle traits gained by species through evolution process. From references it is known that plant species as well as their seeds differ from each other by their longevity (Medvedev, 1990).

Variety diversity along with other features characteristic for species also play a role in viability of collected seeds during storage (Illi, 1982). There is also ground for assuming that viability of seeds according to gene pool heteregeneity representing stratified cumulation of different genotypes may also be stratifed at the level of variety and population within its adaptive norm as a sign of species. Therefore, it may be expected that variety, species and intraspecific plan populations of plants will differ on rate of growing old. Growing old is explained as function of time describing relation between chronological age and probability of death (Grodzinsky, 1986). The phenomena of growing old carries system character (Voitenko, 1986). Its signs become obvious at various levels of structural-functional organization of biological system. It is marked connection of growing old with deterioration of physiological (Illi, 1982) and biochemical (Kanungo, 1982) prosesses, with destruction and denaturation of cell organoids and ultrastructural mechanism of membranes, intracell proteins, lipids, nuclein acids (Roberts, 1978; Illi, 1982), accumulation of growth inhibitors and toxic products of metabolism, including mutagenes (Roberts, 1978; Obukhova, 1986; Veselovsky, 1986). Some authors hold the same views about the leading role of hereditary factors in detection of longevity (Kanungo, 1982; Kirwood, 1988; Slagboom, 1990; Kuznetsova, 1999). The explanations above elucidate that the studies of functional viability of various plant species seeds and varieties and systematic parameters of their genetic longevity has theoretical and practical importance among the complex actions aiming conservation and regenaration genetic diversity of plants genetic resources. Elaboration of functional diagnostics of viability of plant seeds and imitative genetic prognosis models of their longevity also rouse interest among these actions.

These studies aimed creation of universal models suitable for plants belonging to various taxonomic groups, and enabling to give functional diagnostics and genetic prognosis of viability potentials and longevity of their seed samples.

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MATERIALS AND METHODS

The studies focused on two populations of *Agropyron elongatum* (Host.) P. Beauv. species collected from Absheron peninsula growing in rather saline ('Surakhani' area) and dry soils ('Gurd gapisi'), and two cultivated varieties of *Lens culinaris* Medik. species of Lerik and Jalilabad origin. Germination ability of their seeds and frequency of chromosome disorders in root meristem cells have been studied comparatively.

The known methods and accepted formula have been used in germination of seeds and calculation of their germination ability (Seeds of agricultural crops, 2005). One of cytogenetic methods - chromosome aberration tests has been used to investigate disorders occured at chromosome level in genetic structure (Aliyev et al., 1992). Artifical aging method has been used to investigate long-term seed storage (Baskin, 1981; Ward and Powel, 1983; Naylor, 1989).

RESULTS AND DISCUSSION

Genetic potential of seed longevity in example of wild species was studied in early investigations. It was identified that seed samples of species and intraspecific populations grown in diverse soil-climatic condition significantly vary by probability of losing their hereditary integrity during conservation (Mehdizade et al., 2007). As a logic continuation of this work, the current investigation has been focused on the study of functional and genetic changes that might occur in viability and longevity of seed samples of wild and cultivated plant species during storage process and on this basis creation of universal models for evaluation of them for these traits.

At first the studies were carried out over seed samples of two populations of wild *A.elongatum* collected from Absheron peninsula. This option was chosen purposefully. According to references there is certain cryptoelement differentiation inside populations having disjunctive (interval) natural habitat (Agayev, 1979). Therefore seed samples of *A.elongatum* have been collected from those plants grown in rather saline ('Surakhani') and dry ('Gurd gapisi') soils. Initial germination ability of these seeds have been studied. Results are described in the Table 1. As table shows germination ability of seeds of these populations is nearly the same and perform relatively low germination. It should be noted that such case is characteristic for wild plants. Unlike cultivated crops, germination of seeds in wild plants fluctuates over a wide range. It should be taken into consideration that the factor of ontogenetic adaptation exert an opposite effect on occurence of assumed differences on germination period of seeds between populations. There is specific homeostatic balance among generation at each population grown in certain soil-climatic conditions. But it is dynamic. Therefore, the composition of populations is separated into microgroups called cryptoelements, which are morphologically identical, but distinctive by response reaction when cultivated in unusual conditions. It should be noted that cryptoelements stratification inside populations has double-nature. On the one hand, long-term modification variability is characteristic for it, but on the other hand, composition of such homeostatic balanced population is built over genotypes with distinct contrary reaction forms against different factors of growing environment. Therefore, it is proposed creation of "provocation" background as a method that makes possible to identify differences among populations, and it is noted that by this way compositions of populations can be differed from each other according to their contrary responses (Agayev, 1979; Batigin, 1986).

In our investigations imitation model of seed aging has been used as a method of creation of "provocation" background. Seeds of target populations have been subjected to artificial aging. The obtained results showed that at both populations the irritation of seeds by artificial aging causes reduction of their germination ability up to 18-19% (Table 1). But compared samples did not differ significantly depending on changes of this sign. Attempt, therefore, was undertaken to study a genetic nature of intraspecific change of viability potential of seeds.

Frequency of chromosome aberration in root meristem cells irritated through spontan and artificial aging method obtained from seed samples of compared populations has been studied (Table 1). It was found out that the compared populations in controllable variants, that is on a level of spontan disorders of chromosomes did not differ. The available difference is not reliable on a degree of the importance ($P>0.05$). On this background the artificial aging strengthens mutation activity of chromosomes in both populations. In experimental version, 1.5-1.7-fold increase of frequency of chromosome disorders was observed. For each populations the increase of damages irritated by artificial aging in genetic system has been reliable on importance degree. But amplititude of increase of mutational activity of samples collected from population of 'Gurd qapisi' area in comparison with population from 'Surakhani' substantally is high (Table 1). This shows availability of differences among populations by hereditary sensitiveness traits against aging factor. Based on this one can guess that during storage period probability of

Table 1. Germination ability of seed samples of *Agropyron elongatum* (Host.) P. Beauv. populations collected from diverse *in situ* environment and exposed to natural and artificial aging, and frequency of chromosome aberration in root meristem cells of their sprouts

Populations of *Agropyron elongatum* species	Indicators / Options	Germination ability, M±m, %	P	1/ΔM	Total number anaphase cell	Anaphase cells with chromosome aberration		P	ΔM
						n	M±m, (%)		
Surakhani	Control	39.0± 4.88	<0.02	3.1	805	52	6.41±0.86	-	-
	Artificial aging (3 days)					75	9.32±1.03	<0.05	0.4
Gurd gapisi	Control	50.0 ± 5.0	-	-	803	65	8.10±0.96	-	-
	Artificial aging (3 days)	31.0±4.63	<0.01	2.6	798	111	13.91±1.23	<0.001	0.7

the loss of genetic integrity of seeds of 'Gurd gapisi' populations may be relatively higher than that of 'Surakhani' populations. The obtained results correspond with the literary data mentioned above. Thus, on an example of populations of *A.elongatum* species, it was revealed that plant seeds distinguished by growth habitat are different on possibility of losing the genetic integrity during storage period. It was mentioned that by using imitating models of aging as irritating factor it is possible to reveal and evaluate genetic potential of seed longevity.

Analogical studies have been carried out over two cultivated legume species of *L.culinaris* originally from Jalilabad and Lerik belonging to *Lens* family to maintain universality of this model. Comparatively, ability of seed germination from the fresh crops and stored within 1 year at temperature 20°C or 6°C, and then within 6 days subjected to artificial aging, and frequency of chromosome disorders in root meristem cells of sprouts were studied.

The obtained results are presented in the Table 2. As shown in Table 2, in both compared samples of seeds taken from a fresh harvested crop in controllable version possessed high germination rate (98-100%). There is another fact that draws attention. Germination rate of target samples maintained at a room temperature and in a refrigerator for one year remained high. Though germination rate of *L.culinaris* sample of Jalilabad origin was observed insignificantly lower in the same version compared to tested version, but difference is not reliable and has tendency character. The obtained results don't give a ground to utter any opinion about viability potential of samples. Only observation is that germination rate of seed samples maintained one year was not changed. This testifies internal resources of their viability.

According to existing opinions in scientific literature, the extent of mobilization of its internal resources by biological object having interrelation with environment becomes apparent in its contrary response. For this, tension of external influence should reach the bound of adaptation capacity of biological object. It was decided to apply artificial aging method to prove validity of spoken hypothesis. All seeds samples of *L.culinaris* species including newly harvested seeds, those maintained at a room temperature or in a refrigerator for the period of one year exposed to 6-days artificial aging. It was discovered that in all experiments germination rate of seeds dicreases. But experimental variants differed from each other by amplitude of decreasing rate. So, reduction of germination rate of *L.culinaris* species of Lerik origin as reponse to influence has made up 4% for newly harvested seed, 32% for seeds maintained at a room temperature within one year and 14% for those maintained in a refrigerator. It clearly show that internal resources of germination capacity have been more used in the seeds stored at a room temperature for one year compared to those of newly harvested seeds. But seeds stored at a room temperature used less internal resources of germination capacity compared to those stored in a refrigerator.

Analogical legitimacy was observed in samples of Jalilabad origin of *L.culinaris* species. In these samples as in those of Lerik origin reduction of germination rate has made up 30% for seeds of fresh yield, 74% for seeds maintained one year at a room temperature and 50% for seeds stored one year in a refrigerator. As seen, much reduction in internal resources of germination capacity is observed in seeds stored in room conditions (Table 2).

Along with certain common legitimacy for compared samples some differences was also observed among them. As such, compared to samples of Lerik origin germination rate of samples of Jalilabad origin has fallen down 7 times for fresh seeds, 2.3 times for those stored in room condition and 3.6 times for seeds stored in a refrigerator.

Thus, based on analysis explained above one may come to a conclusion that germination rate of seeds may be used as functional factor of their viability potential. From viewpoint of such approach, it was practically proven that samples with different origin, even though belonging the same species, vary substantially by viability potential of seeds. It has been revealed that in comparison with samples of Lerik origin, assumption of reduction of viability potential of samples of Jalilabad origin during storage period is higher.

Table 2. Germination ability of *Lens culinaris* Medik. species seeds distinguishing by origin and chromosome aberration in root meristem cell of sprouts obtained from them (before and after influence of artificial aging factor)

Samples	Options / Indicators	Germination ability, M±m, %	ΔM, %	Quant. of anaphase cells	Anaphase cells with chromosome aberration		P	ΔM
					n	M+m (%)		
Lens culinaris (Lerik)	Fresh seeds	100	-	716	38	5.31±0.84	-	-
	Seeds exposed to 6-day artificial aging	96.0± 2.0	4	695	54	7.77±1.01	<0.1 >0.05	0.46
	Seeds stored for one year at 20°C	100	-	680	37	5.44±0.76	-	-
	Seeds exposed to 6-day artificial aging	68.0±4.7	32	663	71	10.71±1.20	<0.001	0.97
	Seeds stored for one year at 6°C	100	-	684	42	6.14±0.92	-	-
	Seeds exposed to 6-day artificial aging	86.0±3.5	14	630	55	8.73±1.12	<0.1 >0.05	0.42
Lens culinaris (Jalilabad)	Fresh seeds	98.0±1.4	-	658	37	5.62±0.90	-	-
	Seeds exposed to 6-day artificial aging	68.0±4.7	30	671	58	8.64±1.08	<0.05 >0.02	0.5
	Seeds stored for one year at 20°C	94.0±2.4	-	695	42	6.04±0.9	-	-
	Seeds exposed to 6-day artificial aging	20.0±4.0	74	673	98	14.56±1.36	<0.001	1.41
	Seeds stored for one year at 6°C	92.0±2.7	-	520	39	7.50±1.16	-	-
	Seeds exposed to 6-day artificial aging	42.0±4.9	50	609	71	11.66±1.30	<0.05	0.4

In the known scientific literature it is noted that germination rate is one of integral indicator reflecting height and growth of plants and, in general, their viability potential. Close relation between longevity and viability potential is irrefutable. But management of viability potential relies on hereditary body. It is assumed that there is straight proportionality between viability potential and hereditary integrity. Based of the facts of literature data, it is noticed that heriditary damages saved up during time are not connected with chronological age and viability loss (Roberts, 1978; Grodzinsky, 1986).

Practical approval of expressed opinions is justified in legitimacy of changes of samples chromosome disorders. Analysis of results of chromosome aberrations frequency presented in the table shows that there are substantial differences among variants of compared samples, consisting of parties of fresh seeds, seeds stored within one year in a room conditions and seeds, stored one year in a refrigerator. Mutation activity of chromosomes is observed only after being exposed to 6-days artificial aging. Relative increasing of heritable disorders in root meristem cells of sprouts obtained from seeds of *L.culinaris* species exposed to artificial aging was observed as common legitimacy in all experimental options of seeds both for Lerik and Jalilabad origin.

Against this common legitimacy, the compared samples differ from each other by amplitude of increasing of the chromosome disorders. As seen from obtained results, in the experiments carried out with *L.culinaris* species from Lerik origin, artificial aging of fresh seeds and that of stored one year in a refrigerator resulted in substantial increase of heritable disorders. For this sample exact increasing of this rate under influence of artificial aging factor is observed only in seeds stored one year in room conditions. But for seed samples of *L.culinaris* species from Jalilabad origin exact increasing of heritable disorders after influence of artificial aging was observed in all samples including fresh seeds, and that of one year stored in room conditions and one year stored in refrigerator. As in samples of Lerik origin, more increasing of heritable disorders was observed in the seeds stored one year in room conditions. Based on analysis of above described chromosome disorders one may come to a conclusion that assumption of loss of

hereditary integrity of seeds is higher in the samples from Jalilabad origin. Apart from this it was revealed that not depending on the origin assumption of loss of hereditary integrity in both samples stored for one year in room conditions is higher. In this connection one can imagine that loss of hereditary integrity in seeds decreases their longevity. Practical approval of the described dependence may be explained by reverse proportionality relations existing between viability of seeds and load of heritable damages accumulated in them. According to our observations sharp decrease of viability potential of seeds in any experimental samples was accompanied by substantial increase of load of heritable damages in the course of investigations.

Also here should be once again noted that existance of such reverse proportionality relations gives a ground for making prognosis on genetic longevity of seeds. Thus, another model is proposed for functional diagnostics of viability potential of seeds and for genetic prognosis of their longevity. It is shown that by application of this model even within the same species cultivated plant samples distinguishing by only initial origin, diversity of seeds may be explained by their viability potential, by hereditary integrity and by seed longevity.

Thus, in the example of plants belonging to diverse taxonomic groups, new approach is proposed for functional diagnostics of viability potential of seeds and their longevity in individual samples and for making genetic prognosis. Based on this, universal practical models with high decisive capacity have been elaborated and quality factors have been worked out.

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