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THE DECLINE IN VIABILITY AND VIGOUR OF THE HYBRID MAIZE (*Zea mays* L.) SEED UNDER THE INFLUENCE OF GENOTYPE, DURATION AND THE FACTORS OF THE STORAGE ECOSYSTEM

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Abstract

*The objective of this research was to determine the changes in quality of maize (Zea mays L.) seed over the three years storage and in five genetically different hybrids, in during storage, under open storage conditions. Also the aim of this study was to evaluate the effect of different type treatment on physiological potential maize (Zea mays L.) seeds. Five experimental corn hybrids, each represented by five seed lots produced by Agricultural Research and Development Station Turda, Romania, were evaluated. Seeds were stored for **36** months, under different environments and seed performance was evaluated the time of "initial-phase" and every **12** months by seed viability (germination), seed vigour (seedlings length, İndex Vigour-I - **SVI**), Speed Germination Index **(SGI)**. The results indicate that the contribution of the factors taken into consideration, at the total variability of viability (germinations) is: hybrid, **26.01%**; storage conditions (treatment), **9.99%**; storage duration, **31.75%**, and in case of seed's vigor variability (İndex Vigour-I) is: hybrid, **5.5%**; treatment, **25.20%**; storage duration, **46.69%**. The study's purpose was to identify which of the studied genotypes preserves better its initial seminal qualities during storage duration. The large variation range of regression coefficient b_i[0.30 - 1.684] and of determination coefficient R_i^2 [0.68 - 0.90], residual deviations δ_{ij^2} and of ecovalence coefficient W_i^2, indicates the fact that there are differences regarding the behaviour of genotypes in analyzed environments which means differente reactions of hybrids taken into consideration, targeted by the storage conditions and storage duration. A model was developed for **viability equations** to quantify the effect of storage conditions to „open space" on the orthodox seeds (Zea mays L.) deterioration.*

***Key words**: maize, seed viability, seed vigour, storage conditions.*

INTRODUCTION

The economical importance of maize since the usage of its caryopsis in the human food, in industry and in animal feed, of strains as feed or in the pulp industry, with a production capacity, about 50% higher than the other cereals, it would not have been possible without the genetic potential and the diversity of physiological expression existing within the seed, life-bearing and genetic patrimony.

The maize seed multiplication activity in U.E. is increasing from year to year as a result of increased seed demand, but annual losses due to deterioration, for various reasons, are over 25% (Iyoti and Malik, 2013).

One of the main reasons for annual seed losses is the insufficient knowledge of the influence of all factors with action, in pre-harvest, during harvest and conditioning, and during storage, on the chemical, physical, biochemical and physiological changes occurring at the metabolic and structural level of the seed (Bărbos et al., 2016). Another reason, are the actual climatic changes which brings changes in the physiological activity of the seed as a result of the increase of entropy with influences, not only during production in the field but also during storage (Duda and Moldovan, 2008).

All the bibliographic sources emphasize that among the many factors that contribute to the realization of the complex character, Production capacity the *seed's quality* is also included. The expression ***„seed's quality"***, is a concept and includes several components highlighted by Ajavi (2003): ***genetical quality*** (biological value), ***mechanical quality*** (resistance to damage) ***health quality*** **(**health level and health status), ***physical quality***, („eye's pleasure") ***physiological quality*** (refers, to germination potential and physiological manifestation), ***storage quality*** (conservation).

As a very important biological factor in the increase of production, the quality of the seeds from the agricultural point of view is given by their genetic and somatic value. Measures to mitigate the impacts of climate change or to improve agricultural technologies to provide the food needed for the continuity of life on earth begin with the use of a *high biological* value seed with high parameter values which characterizes its ***viability and vigour***, a seed resistant to abiotic and biotic stress factors.

The following factors are ***fundamental*** in terms of keeping seed quality during storage: *moisture content of the seed subject to storage, relative humidity and temperature in the storage medium, seed quality (initial quality) in the moment of storage and the destructive attack of microorganisms and insects.* In order to limit the action of these factors on the *normal seed aging process*, with consequences on seed quality, it is necessary to know, control and regulate this process in order to increase the longevity of the seeds, meaning to extend the useful life of the seed lots with the consequences under the economic aspect and the safety of agricultural production.

In order to meet demand, seed technology research has focused on identifying various aspects that may be associated with the physiological potential of seeds. It is therefore necessary to know the actual condition of a seed lot in terms of quality, assessing its degree of decline, to provide useful information to the user, thus helping him to decide the manner, the conditions and the time of use of the lot.

Viability represents the potential seed capacity to generate live embryos under optimum conditions. Because, standard germination***, viability indicator*** (Baldwin et al., 2006) reflects the maximum seed germination potential under optimal conditions, it is not a good indicator to correlate with field emergence (Duurant and Gummerson, 1990; Morad, 2013).

In order to obtain precise information on the quality of a seed lot, even if they have almost identical germination values, *different vigor tests* should be used (Milosovic and Cirovic, 1994; Perry, 1981). The **ISTA** Association, in 2014, develops a comprehensive definition of the concept of seed vigour: *„seed vigour is the sum of those properties that determine the activity and performance of seed lots of acceptable in a wide range of enviroments; a vigorous seed lot is one that potentially able to perform well under environmental conditions which are not optimal for the species"*.

The size of the increases of the essential parts of germs and the dry weight of these increases are directly proportional to the vigor of the seeds, their degree of deterioration, either due to aging or other causes (Matthews, 2007). At the same time, they are good indicators to differentiate between seed lots in terms of the potential of their physiological expression, but can be very well correlated with field emergence under varying conditions (Ching et al., 1972; Perry, 1981; Hermanus-Maree, 2008; Milosovic et al., 2010; Divasalare et al., 2013).

The particularity of the „orthodox" seeds for sowing is that they can be stored in a dry state in open warehouses for a longer or shorter period depending on the values of the fundamental parameters characterizing the storage medium.

MATERIALS AND METHODS

The conditions in which the experiments took place

The research presented in this paper began in 2014, at SCDA Turda, Romania, and ITCSMS Cluj-Napoca, Romania, during 2014-2017. Storage (open space), thermally insulated, providing small variations of environmental parameters in space, at the major changes of the outside, with a temperature variation during the year, 8-28°C and relative variation, 25-75% humidity with the possibility of applying natural aeration. Cold laboratory room (controlled environment) with a temperature variation during the year, 2-4°C and relative variation, 50-75% humidity, intended to test natural resistance, the potential of hybrids to form normal germs under such conditions.

Factors and experimental design

The storage conditions are referred to as **treatment** with subsequent graduations: an open room (warehouse) where untreated seed is stored; laboratory chamber with controlled medium in which untreated seed is stored; room (open space) with *seed treated fungicide* Maxim XL 0.35 FS; open room with seed treated with *fungicide* Maxim XL 0.35 FS + *insecticide* Seedoprid 600 FS.

Corn genotypes have a different FAO group but also different initial qualities and come from homogeneous maize lots in terms of physical qualities (size), with initial humidity of approx. 12% and good health: *Turda 200*; *Turda 165*; *Turda 201*; *Turda Star*; *Turda Favorit*.

Storage duration with graduations: *before sowing-2015* is the initial moment of researches; *after 12 months*; *after 24 months*; *after 36 months*.

Environmental factor, $E_{env,}$ with levels: $E_1, E_2, E_3, ..., E_{16}$ results from the combination of two unified factors: treatment and duration of storage.

The experimental design:

Completely Randomizat Design (RCD) of type:

* **4 x 5 x 4** - four repetitions for the study of viability and vigor;
* **5 x 16** - four repetitions, to study the stability of viability, under different experimental conditions.

Statistical Analysis

The methods and techniques used in the studies conducted in this paper are given below in order of their use during the research:

* ANOVA for Regression Analysis and calculating the magnitude of the effects
* the concept of stability-preservation of the initial (original) qualities, after the linear dependence of Eberhart and Russell (1966):

$$y_{ij} = \mu + b_i \cdot I_j + \sigma_{ij} + e_{ij}; \qquad (1)$$

* Vigor index-I **(SVI)** (Abdul Baki and Anderson, 1973):

$$SVI = \text{Germination (\%)} \times \text{total seedling length (root + shoot)} \qquad (2)$$

* Speed germination index **(SGI)**, (AOSA, 1983):

$$SGI = G_1/N_1 + G_2/N_2 + \ldots + G_n/N_n \qquad (3)$$

* Complex equation of viability (Ellis and Roberts, 1980) :

$$v = K_i - \frac{P}{10^{K_E - C_W \log(mc) - C_H t - C_Q t^2}} \qquad (4)$$

Model simplified of viability (Andreoli, 2004):

$$v = K_i - 1/\sigma * p \qquad (5)$$

where, **1/σ** is the slope of the survival curves seeds, which corresponds to, $10^{K_E - C_W \log(mc) - C_H t - C_Q t^2}$

RESULTS AND DISCUSSIONS

Study of the viability of seed lots

The *start-up* phase of the research, the*before sowing-2015* phase, was considered to be when determining the indicators that characterize the initial viability, but also those regarding the vigor of seed belonging to the studied hybrids. The analyzed hybrids belong to different FAO groups, thus deviated physiological maturations, this means practically an extended harvest of cobs (in the autumn of 2014) and at different seed moisture hybrids.

Analyzing the germination values (***SR 1634/1999) obtained for each hybrid at this *before sowing* stage, on each level (graduation) of the treatment factor, significant differences can be observed between the majority of the experimental variants on recorded germination (Table1). These differences are determined not only by the graduation of the treatment factor but also by the genotypes studied. For example, in the variant *untreated* version we have: Turda 200 **(98%)**, Turda 165 (**92%**), Turda 201 (**96%)**, Turda Star **(97%)**, Turda Favorit **(95.5%)**. The results of the trifactorial experiment on the studied feature, ***standard germination***, highlights, the intake of **31.7%**, of the factor ***storage duration***, on their total variability, followed by the contribution ***of hybrid* 26%**, as well as a significant contribution to the interaction ***hybrid x storage duration*** of **10.3%,** and interaction ***hybrid x storage duration x treatment of* 7.65%** (Figure 1). As time goes by, as a result of the degradation of the enzyme system of substance use, the decline in germination capacity of seeds is accentuated (Murariuet al., 1998).

This is shown by the experimental results obtained in the *after 36 months* stage. The very low values recorded for seed germination, in the 36-month stage, in the case of some hybrids, Turda 165 (**G_{36}=78%**), Turda 201, Turda Favorit, show the different capacity to preserve the qualities of the attributes that define them as biological material, and that this is a genetic feature of each hybrid, influenced differently by the storage conditions (Figure 2).

By an experimental condition imposed, *controlled environment* with specific parameters whose values imply a predictable negative evolution of the seed quality of the hybrids under study, the *natural resistance* is tested, their potential to form normal germs under such conditions. After *36 months* storage duration, a poor behavior of hybrids is highlighted under these conditions, Turda 201 **(G_{36}=68%)**, Turda 165 **(G_{36}=73%)** and Turda Favorit (**G_{36}=76.5%**).

Table 1. Combination of studied factors in the experiment on maize

THE COMBINED TABLE OF FACTORS (germination, % - average values)					
Treatment	Genotype	Duration of storage			
		initially	after 12 months”	after 24 months”	after 36 months”
Untreated	Turda 200	98.00	96.75	96.00	96.00
	Turda 165	92.00	93.00	86.50	78.00
	Turda 201	96.00	96.50	92.50	89.00
	Turda STAR	97.00	96.00	94.00	90.75
	Favorit	95.50	92.75	90.00	88.50
Controlled environment	Turda 200	98.00	94.00	92.50	91.50
	Turda 165	92.00	92.00	82.50	73.00
	Turda 201	96.00	97.00	87.25	68.00
	Turda STAR	97.00	95.25	91.50	87.25
	Favorit	95.50	87.25	84.50	76.50
Fungicide	Turda 200	97.00	95.75	96.00	94.75
	Turda 165	93.50	94.00	89.75	84.00
	Turda 201	96.50	96.00	94.50	92.50
	Turda STAR	97.00	97.00	94.75	93.00
	Favorit	95.00	95.00	93.25	92.75
Fungicide + insecticide	Turda 200	97.50	95.50	94.75	93.75
	Turda 165	93.25	86.25	76.25	62.00
	Turda 201	96.00	95.50	92.75	86.50
	Turda STAR	96.25	94.50	93.00	91.00
	Favorit	94.00	84.50	86.00	76.00

$LSD_{5\%}$=1.64; $LSD_{1\%}$=2.16; $LSD_{0,1\%}$=2.80

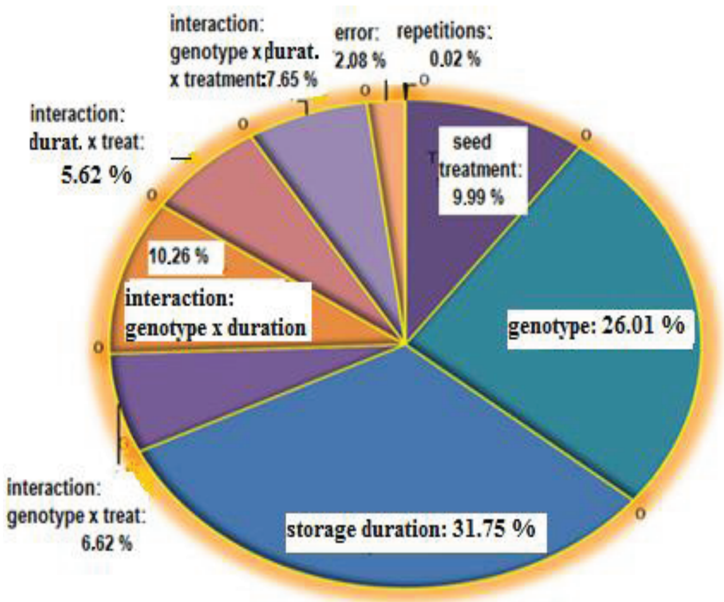

Figure 1. Factors contribution to total variability

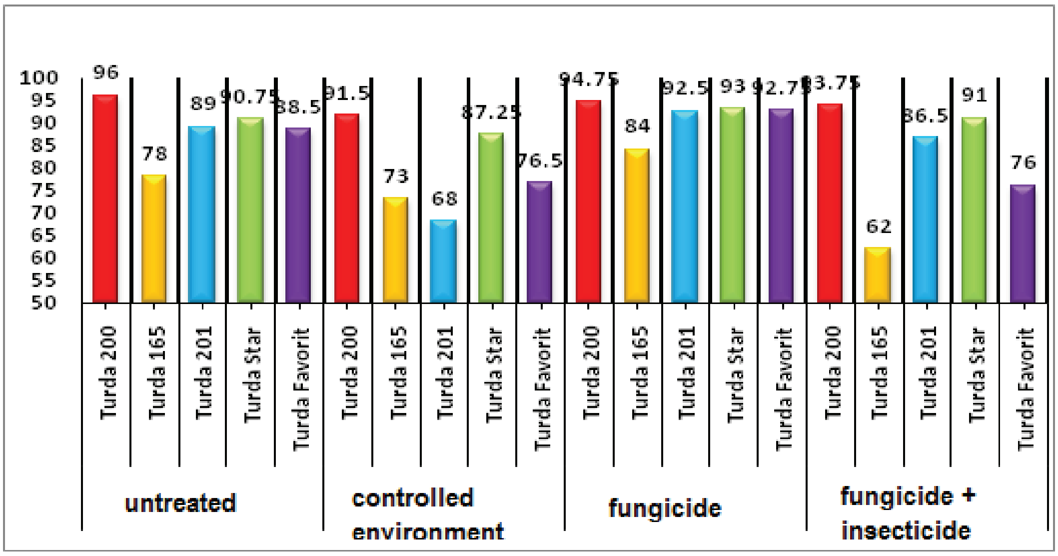

Figure 2. Treatment x genotype interaction effect (after 36 months)

By the fungicide seed treatment procedure, a better conservation of germination is particularly evident in Turda 165 hybrids (**G_{36}=84%),** versus untreated variant (G_{36}=78%), Turda Favorit (**G_{36}=92.75%)**, and Turda 201 (**G_{36}=92.5%**).

The fungicide treatment operation has proven to be a solution to increase seed longevity, thereby reducing the aging process.

Combined *fungicide* + *insecticide* protection for simultaneous disease and pest control is a good measure to improve seed health and provide the necessary seed protection.

The experimental results obtained in the experimental version *fungicide* + *insecticide* show that the seed with this combination treatment declines after a storage of less than 12 months, which means that keeping these seeds for a longer period of time is not recommended. Hybrid Turda 165, in the end, in this experimental condition, records the germination (**G_{36}=62%**) and a good resistance and tolerance has been shown to have the Turda 200 hybrid and Turda Star.

It is known that certain insecticidal substances by the metabolic process release free radicals, which exerts an exogenous reaction on the seed, leading to the decline of the activity of the enzyme system.

The study of viability stability of seed

We aim in this study to identify genotypes more or less stable from a phenotypic point of view and to assess the individual performance of each regarding the preservation of the initial seminal qualities under different experimental conditions.

The existence of the interaction: **genotype x environment (G x E_{Med})** makes possible, that the same genotype does not express itself in the same way in different environments, which means that he will not make the same contribution to phenotypic manifestation and vice versa different genotypes (can) respond to the same environment in different ways, which means that genotypic contribution to the phenotypic variant is not independent by genotype (Larmat, 1977).

By the fact that both components of the interaction **(G x E_{Med})** (Table 2), both the linear component **(G x E_{med}-liniar)** as well as the ***residual*** variance **(S^2_{rez})** are significant, highlights the fact that there are ***differences in the behavior of genotypes***, and the response of genotypes under experimental conditions can be quantified in strongly linear dependencies (all or only some of the genotypes) but also contain a portion that is quantified in non-linear expressions, in which case the response can not be estimated and reactions are unpredictable.

Results on Regressionl analysis (Maniu and Voda, 2006) and effects size, regarding, stability of characteristic, standard germination allowed assessing the effects of each factor, which in percentage terms represents: genotype, **27.9%**; environment (experimental conditions), **41.4%**; interaction genotype **x** average, **28.1%**

Table 2. ANOVA program for the Regressional Analyse and sizes effects

Cause of variability	Degress of freedom (df)	The average square (δ)	Variances estimated (σ^2)	Effects (%)
Replication with environments	**e (K-1) = 48**	**1.274**	**-**	**-**
Genotypes, G	**q – 1 = 4**	**255.773^{XXX}**	**$\sigma_э^2 + k*\sigma^2_{qxe} + e*k*\sigma^2_q$**	**3.75 (27.9%)**
Environments, E_{env}	**e -1 = 15**	**126.818^{XXX}**	**$\sigma_э^2 + k*\sigma^2_{qxe} + q*k*\sigma^2_{med}$**	**5 (41.4%)**
Interaction, G x E_{env}	**(e -1)(q – 1) =60**	**15.42^{X}**	**$\sigma_э^2 + k*\sigma^2_{qxe}$**	**3.77 (28.1%)**
Env. + G x E_{env}	**q (e -1) = 75**	**-**	**-**	**-**
Environments-linear	**1**	**1902.28^{XXX}**	**-**	**-**
G x E_{env}.- linear	**q – 1 = 4**	**120.70^{XX}**	**-**	**-**
Pooled deviations	**q (e -2) = 70**	**6.33^{X}**	**-**	**-**
Pooled error	**e (q – 1) (K-1) = 192**	**1.41**	**(S_E^2/K=0,35); $\sigma_э^2$**	**0.35 (2.6%)**

The calculated values of the specific parameters that assess the individual capacity of each genotype individually (individual stability) are presented in Table 3.

Wide variation of regression coefficient **bi**, between [**0.307-1.684**], as well as the determination coefficient **R_i^2 [0.68-0.90]**, indicates that the studied hybrids react, behave differently from the environment.

Contribution of each genotype to the interaction G x E_{med} is measured by the coefficient of ecovalance **W_i^2**, which is also desirable to have as little value as possible. Turda Favorit with a *regression coefficient* value close to one (**b_i=1.18**) and a small residual deviation, **δ_{ij}=4.9492** is considered to have a mean stability of the initial features.

Genotypes with a *regression coefficient* **b_i>1**, as in our case Turda 201 (**b_i=1.274**) and Turda 165, (**b_i=1.684**) characterized them as genotypes with inferior stability in terms of keeping germination under different experimental conditions.

Table 3. Values of regression coefficients (b_i), residual deviations (δ_{ij}), ecovalence coefficient (W_i^2) and determination coefficients (R_i^2)

Genotypes	*Regression coefficients*[bi]	*Residual deviations* [δ_{ij^2}]	*Ecovalence coefficients*[W_i^2]	*Determination coefficients* [R_i^2]	*Regression* heterogeneity *coefficients* [$\beta_i^2 = (1 - b_i)^2$]
Turda 200	**0.307**	**1.153**	**97.6089**	**0.68**	**0. 48**
Turda 165	**1.684**	**12.727**	**357.5561**	**0.86**	**0. 47**
Turda 201	**1.274**	**11.910**	**195.8742**	**0,78**	**0. 07**
Turda Star	**0.537**	**0.8923**	**91.9172**	**0.90**	**0. 21**
T. Favorit	**1.185**	**4.9492**	**83.4014**	**0.88**	**0. 03**

Subunit values of the *regression coefficient* **bi<1** registered for Turda 200 (**b_i=0.307**) and Turda Star (**b_i=0.537**), characterizes them as very stable genotypes with reduced sensitivity to storage conditions.

Equation of seed lot viability

The evolutionary prognosis of viability in the study in this paper is a difficult task due to the complexity of the physiological and biochemical phenomena and the presence of a large number of influential factors.

The model presented Ellis and Roberts (1980) **is complex** and **difficult to solve**, so we considered that the evolution of the whole system can be relatively well described by retaining the most relevant elements. For the elaboration of the *linear mathematical* model characterizing the behavior of each genotype in a given environment, the transformation of the distribution of cumulative seed survival frequencies was reversed (percents versus time), in ***distribution of scores „z”***, values without unit of measure and distributed on a. straight line.

The regression slope has been assimilated (germination versus storage duration) with **the *deterioration rate*** (the slope of the fall of germination), elaborating for each hybrid a mathematical model called the ***equation of the seed's viability***, of the form:

$$v=K_i - tg\ \varphi * p \qquad (6)$$

where: **v**-is the seed viability in probit;
K_i - is the probit of the percentage viability at the beginning of the storage period;
φ - the angle of the straight line (°);
p - storage duration (days);
d=tg**φ** (the coefficient of the slope of the straight line), is the seed *deterioration rate.*

To better illustrate the usefulness of equations, to differentiate the seed lots and a more accurate appreciation of their quality after a certain retention period, we will use the graphic method.

On the axis of the ordinates is represented on the left the *transformed germination* in scores, **z**, and on the right remained in percent **(%)**, and on the axis of the abscissae is represented the *storage duration* (**p**), *in days*, of seed (illustrated version: *untreated seed* stored in open space) (Figure 3).

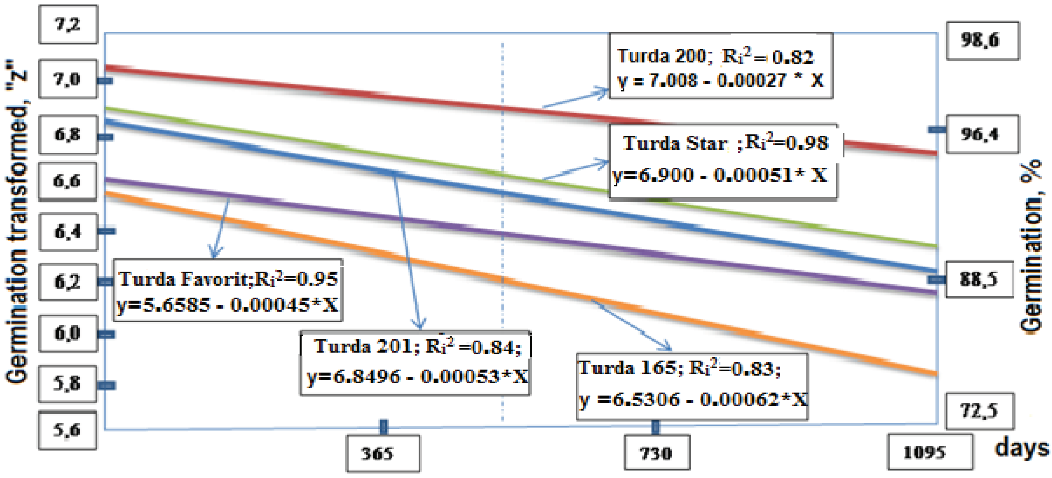

Figure 3. The slope (rate) of deterioration of untreated seed lots from the studied hybrids, stored in "open space"

Indicator **d**-*deterioration rate*, reveals an aspect difficult to be found through other methods, genotypes with superior germination in certain environments, records during storage much higher rates of decline. Example, Turda Favorit has the initial average germination of 95.5%, and Turda 201 the initial average germination of 97%. Appreciate by coefficient size, *deterioration rate,* Turda 201 hybrid, has a rate **(5.3×10^{-4})**, bigger than Turda Favorit **(4.5×10^{-4})**, which is clearly visible after the slope of the two graphically drawn dependencies (Figure 3). From the graph, one can appreciate, the good behavior of the Turda 200 hybrid in this environment, with the lowest damage rate, of only, **2.7×10^{-4}**.

Study of the vigor of seed lots

Different lots of seeds, even if they have the germination (sometimes almost identical), do not mean they have the same physiological potential, that is to say, when sowing in the field, do not show the same uniform germination and sprouting.

The physiological manifestation of seed vigor can not be measured directly, but can be highlighted by a series of tests to assess the growth of essential germ elements (*** ISTA, 2003) (Table 4).

It is noted that as the storage duration increases, at each treatment level and for each hybrid, the sizs of growth of the essntiale parts of the germs, decreases considerably.

A remarkable increase in the root system is recorded for Turda Favorit and Turda 201 hybrids, as well as the positive action of fungicide treatment on them.

Seeds with dynamic and uniformity of germination ensure uniformity of emergence as well as a rapid rise, which means a short time out of any stresses caused by unfavorable conditions (Moldovan et al., 2015).

In the ***before sowing*** phase, very small differences are recorded, between he values of

Speed Germination Index (***SGI***), in case of all hybrids (Figure 4). Starting with the after 12 months stage and as the retention time increases, there are obvious differences between hybrids, with drops in their value after 36 months to 13.3% (untreated seed variant) for some hybrids.

The combined action of speed germination and slow growth rates has consequences on slow and unevenly emergence in the field, even under favorable conditions.

From the comparison table in the experiment, it was shown that there *are significant differences* between germinations of hybrids from the ***start.***

Appreciating the quality of seed lots, after *Vigor Index-I* (***SVI***) (Table 5) and taking into account that the limit difference is ***$LSD_{5\%}$=178.3,*** determined by trifactorial ANOVA of İndex, it is noted that there *are no significant differences*, at this stage (initially) in terms of quality appreciated by vigor in indicators (Vigor Index-I).

Table 4. Values of increases of primary roots and seedlings by treatment and analyzed moments

Hibrids	Treatment	Length of primary root (average) [cm]				Length of plantlet (shoot) (average) [cm]			
		initially	12 months	24 months	36 months	initially	12 month s	24 months	36 months
Turda 200	Untreated	24.66	24.00	23.33	22.66	12.33	12.33	11.66	11.00
	Controlled env.	24.66	20.00	15.66	11.33	12.33	12.00	8.00	8.00
	Fungicide	25.33	26.66	25.00	24.00	12.66	13.00	13.00	11.33
	Fungi.+insecticide	26.33	26.66	16.33	14.33	12.66	12.66	8.33	8.00
Turda 165	Untreated	24.33	24.00	23.66	23.00	12.00	11.66	11.00	11.00
	Controlled env.	24.33	18.66	10.33	10.66	12.00	10.33	6.00	6.00
	Fungicid	26.00	27.00	23.33	19.33	12.33	12.00	11.00	10.33
	Fungi.+insecticide	26.33	23.00	11.33	10.00	12.66	11.00	6.66	6.66
Turda 201	Untreated	25.33	24.66	23.33	21.00	13.00	12.00	11.33	10.66
	Controlled env.	25.33	18.33	11.00	9.00	13.00	10.00	6.66	6.00
	Fungicide	26.33	26.66	23.00	20.0	14.33	14.00	12.33	11.33
	Fungi.+insecticide	26.66	22.00	12.66	10.33	15.00	12.66	7.00	6.66
Turda Star	Untreated	24.33	25.00	24.33	23.33	12.33	12.00	11.66	12,00
	Controlled env.	24.33	20,66	13.66	10,00	12.33	12.00	9.00	8.33
	Fungicide	25.00	25.00	25.00	21.00	14.33	14.00	12.00	11.66
	Fungi.+insecticide	26.00	25.66	16.00	14.00	13.66	13.33	10.00	9.00
Turda Favorit	Untreated	24.00	24.00	23.00	22.33	11.66	12.00	11.33	11.00
	Controlled env.	24.00	20.00	10.00	10.33	11.66	9.66	6.66	6.00
	Fungicide	26.00	25.66	22.00	21.33	13.33	13.33	11.33	11.33
	Fungi.+insecticide	26.66	22.33	11.00	10.33	13.33	12,00	7.66	6.33

Seed deterioration is a natural phenomenon *that can not be stopped*; seeds even kept under normal conditions tend to decrease in viability and vigor with the increase of storage duration.

Analyzing the hybrids after the standard germination parameter, for example in the, *after 24 months* step in the standard version (Table 1), we can say that all hybrids record lower germination values than the initial lower values, but these values do not restrict the seed law, Law 266/2002-republished.

Analyzing seed quality in the stage after 24 months according to Vigor Index-I, it is noted that there are large differences between the initial values and the values recorded at this stage for this indicator.

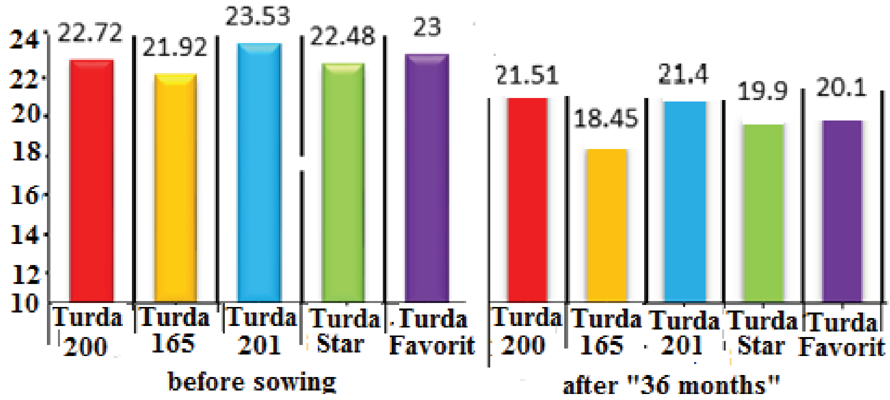

Figure 4. Speed germination index (SGI)

Table 5. Variability of the distribution of results in the vigour - Index analysis

Treatment/hibrid		initially $\bar{I}_{index} \pm t_{5\%} * s_{\bar{i}}$	12 months $\bar{I}_{index} \pm t_{5\%} * s_{\bar{i}}$	24 months $\bar{I}_{index} \pm t_{5\%} * s_{\bar{i}}$	36 months $\bar{I}_{index} \pm t_{5\%} * s_{\bar{i}}$
		$[min - max]$	$[min - max]$	$[min - max]$	$[min - max]$
Untreated	Turda 200	3425.3 ÷ 3810.7	3312.2 ÷ 3711.2	3132.5 ÷ 3567.5	3019.2÷ 3447.4
	Turda 165	3165.2 ÷ 3521.4	3091.3 ÷ 3518.7	2742 ÷ 3258	2392 ÷ 2908
	Turda 201	4788.6 ÷ 5137.8	3333.5 ÷ 3735.1	2942 ÷ 3458	2523 ÷ 3110.4
	T. Star	3368.3 ÷ 3724.3	3518.5 ÷ 3791.5	3079.9 ÷ 3653.5	2928.5 ÷3504.9
	T.Favorit	3201.8 ÷ 3580.2	3039.2 ÷ 3627.4	2802 ÷ 3398	2680.8 ÷ 3225.2
Controlled env.	Turda 200	3424.3 ÷ 3811.7	2769.2 ÷ 3246.8	1909.2 ÷ 2455.4	1456.2 ÷ 2051.4
	Turda 165	3165.4 ÷ 3521.4	2304.5 ÷ 3012.3	954.9 ÷ 1724.5	830.2 ÷ 1623.2
	Turda 201	3491.7 ÷ 3841.7	2380.9 ÷ 3075.7	1129.1÷ 1898.9	639.1 ÷ 1408.9
	T. Star	3368.3 ÷ 3724.3	2882.9 ÷ 3356.1	1726,6 ÷ 2406.8	1263.7 ÷ 1936.3
	T.Favorit	3201.8 ÷ 3580.2	2207.7 ÷ 2925.7	1009.3 ÷ 1768.7	852.7 ÷ 1647.3
Fungicid	Turda 200	3505.2 ÷ 3864.8	3577.2 ÷ 4017.6	3448,6 ÷ 3885,4	3126,6 ÷ 3573.4
	Turda 165	3376.8 ÷ 3769.8	3447.6 ÷ 3884.4	2853.7 ÷ 3337.1	2225.4 ÷ 2746.6
	Turda 201	3717.4 ÷ 4104.6	3676.6 ÷ 4130	3067.5 ÷ 3638.5	2600.2 ÷ 3171.2
	T. Star	3638.2 ÷ 3985.8	3572 ÷ 3994	3298 ÷ 3720	2797.9 ÷ 3244.7
	T.Favorit	3509.9 ÷ 3946.7	3418.5 ÷ 3989.5	2810.6 ÷ 3366.6	2718.1 ÷ 3313.9
Fungicid + Insecticid	Turda 200	3663.5 ÷ 3936.5	3544 ÷ 3966	2041.8÷ 2631.6	1781.9 ÷ 2387.5
	Turda 165	3437.2 ÷ 3834.4	2634.2 ÷ 3239.8	996.1 ÷ 1740.9	665.8 ÷ 1460.2
	Turda 201	3764.2 ÷ 4235.8	3099.7 ÷ 3720.3	1448.5 ÷ 2218.1	1043.4 ÷ 1862.6
	T. Star	3646.8 ÷ 4019.2	3459.9 ÷ 3906.7	2127.1 ÷ 2722.9	1789.7 ÷ 2410.3
	T.Favorit	3542 ÷ 3964	2607.5 ÷ 3178.5	1222.7 ÷ 1977.3	860.8 ÷ 1672.6

Values of the variability coefficient, **C**$_v$, of İndex, increase with the growth of the storage duration, which explains the continuous, cumulative deterioration process of the seed of hybrids studied, in terms of physiological manifestation.

However, most values of the coefficients of variation, have values under **10%**, which shows that experimentation has been carried out correctly, and the results have scientific value. The evolution of *Vigor Index-I* during storage, represented by its mean values, on each treatment, was graphically represented (Figure 5).

We note, very low values, a drop, a "break" of the values recorded for the *Vigor Index-I* between the *after 12 months* and *after 24 months* stages for all variants.

The decline seed is a natural process that involves changes in physical, biochemical and physiological in the seed, with consequences on the viability and vigor, and is carried out with an intensity that depends on the genetic particularities of each *species, genotype or variety*. The mechanisms involved in the deterioration of the seed and the possible transformations, taking place differentiate between the seed lots.

Therefore, the *Vigor Index-I* **(SVI)** and *Speed Germination Index* (**SGI**), provides additional information on the quality of the seed lot and the recommendations on the use of the lot may be altogether different from those outlined only by the *standard germination* **(G)** indicator.

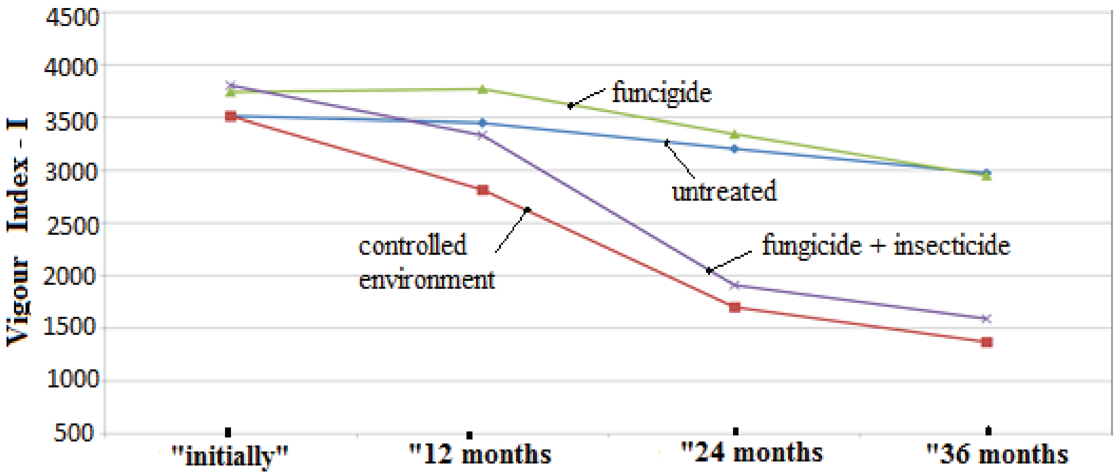

Figure 5. Variation of hybrids Vigour Index-I, during storage duration

CONCLUSIONS

High variability (almost 30%) of the germination value recorded during storage for the „orthodox" seeds belonging to studied hybrids, indicates he different conservation capacity of the initial seed features of each genotype, and that this, is a genetic feature of each, influenced differently by the duration and storage conditions.

The intensity of seed decline may be reduced by controlling and directing the fundamental parameters that characterize the storage conditions.

The results show that the ***fungicide treatment*** of stored seeds reduces the rate of seed decline, which means increasing the seed lot longevity, for example by treating the hybrid Turda Favorit with fungicide, the decline rate decreases more than doubled, from **d=4.5 x** $\mathbf{10^{-4}}$ decreases to **2.0 x** $\mathbf{10^{-4}}$

Through combined protection against both diseases and pests, seed treated with fungicide + insecticide, ***it is recommended to be used in the current year***.

Appreciating the seed quality of the hybrids according to the standard germination indicator, even after a 36 *months* storage, some hybrids still have high germination values, but taking into account the values of the indicators that characterize seed vigor, in most cases it is recommended to use the seeds until the ***24 months*** storage period.

In practice and with wide use, the conservation of the seed quality of hybrid maize (*Zea maize* L.) seeds at a high level for a longer period of time can be done if the seed at the time of storage has moisture below **12%**, and the storage store is a dry, well-insulated building, without special facilities, only with the possibility of aeration, thus ensuring an average annual relative humidity below **55%**, and an average anual temperature below **18°C** with a variation between **0-35°C**, depending on the season.

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