PREDICTION OF LIFE DURATION OF MAIZE (*ZEA MAYS* L.) SEED, PRESERVED IN GENE BANKS, BY BASIC VIABILITY EQUATIONS

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ABSTRACT

**Maintaining of seed viability at high and constant level represents the main objective of genetic conservation.
The purpose of this study was to determine the simultaneous influence of temperature and moisture on maize seed viability and on the activity of catalase, as well as the estimation of the decline of seed viability and enzymatic activity with a mathematic model proposed by Ellis and Roberts (1984). The values of seed viability, determined by conventional germination tests, were very close to the corresponding values predicted by basic equations only for the temperatures of –20°C, 4°C and 20°C. As for catalase enzymatic activity, values were close only for the temperatures of 4°C and 20°C. For the other temperature levels, obvious differences were registered.**

Key words: anabolical process, catabolical process, catalase, amylase, peroxidase, titrimetric method.

INTRODUCTION

Genetic conservation means long-term conservation, for unlimited time if possible, of the favourable genes from plants and animals. In plants, basic conservation is made using seeds. Knowledge as exact as possible of the conditions determining the maximum seed viability is the basic problem in genetic conservation (Cristea, 1985).

During seed development, anabolic processes increase and dry matter accumulates, including embryo development and storage substances. Concomitantly to seed maturation, the biochemical changes continue, being dominated by catabolical processes and deleterious transformations become visible (Abdul Baki and Anderson, 1972).

Seed moisture decrease below certain limits has as effect the reduction of enzymatic activity, and consequently the production and accumulation of toxic compounds (Roberts, 1981).

Some oxydative enzymes (catalase, amilase, peroxidase, etc.) are involved in viability determination of the seed subjected to conservation (Blakman and Leopold, 1993).

Different authors reported changes in enzymatic activity of seed catalase, associated with seed deterioration (Crocker and Barton, 1963; Zeleny, 1968; Anderson and Brown, 1972; Roberts, 1982; Murariu et al., 1994).

The studies carried out in the last decades, concerning the effects of storage conditions on life duration, resulted in the estimation of basic equations of seed vibility. Such equations were communicated for wheat (Roberts, 1960), rice (Roberts, 1961), rye and barley (Ellis and Roberts, 1984), faba bean, pea and bean (Wilson et al., 1989).

The research performed by Roberts (1980) and Roberts and Abdalla (1988) showed that the basic viability equations are applicable only for determined levels of temperature and moisture within each species.

Estimation of the interval of time required for remultiplication of maize seeds from gene banks represents an important aspect of their conservation. At present, germination test of seed from gene banks is made according to the regulations of the International Seed Testing Association (ISTA) as well as by the sequential test proposed by Ellis and Roberts (1980). The standard ISTA method for germination is based on a determined large number of seeds (400 kernels) which is sampled from each entry. The sequential test requires a reduced number of seeds (40 kernels) but it is more difficult to be used.

Starting from these considerations, we appreciated as opportune to apply the basic equation for seed viability enzymatic activity to other species than those mentioned above, in our case to maize seeds preserved in the Gene Bank of Suceava, Romania.

MATERIALS AND METHODS

The effect of temperature and moisture on seed viability and enzymatic activity of catalse was determined in a polyfactorial experimental system with four temperature levels (-

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20°C; 4°C; 20°C and 40°C) and a gradient of five levels for the moisture factor (7%, 10%, 15%, 20% and 25%).

The biological material was represented by seed samples from the maize hybrid Suceava 97. Samples were dried with warm air at the temperature of 37°C until 7% moisture. Seed viability determined for this moisture level was 93%.

Maize seed sample was divided in equal parts for getting the twenty combinations of treatments. Two cycles of experimentation were achieved with a duration of 240 hours each.

Seed viability was determined according to international regulations for seed viability testing (ISTA, 1986).

Catalse activity was determined with the tritimetric procedure (Dumitru, 1977).

The basic equation of viability, proposed by Ellis and Roberts (1960) and improved by Roberts (1984) was used to estimate the decline of seed viability, as follows:

$\log p = K_V - C_1m - C_2t$

were: p = seed vibility for a determined period of time;

m = moisture;

t = temperature;

K_V, C_1, C_2 = constant values

Analysis of variance, correlation coefficients and the corresponding regression equations between the measured parameter and experimental factors were used for data interpretation (Ceapoiu, 1968).

RESULTS AND DISCUSSIONS

The simultaneous influence of the two experimental factors, temperature and moisture, on the viability of maize seed and enzymatic activity of catalase was revealed by variance analysis for the regression (Table 1).

Table 1. Variance analysis for multiple regression (MR) between the parameters analysed and the experimental factors

Parameters	Source of variation	Sum of squares	DF	Mean squares	F values
Seed viability	MR	1932.21	5	386.44	
	Rest	547.59	14	39.11	9.88***
Catalase activity	MR	47.36	5	9.47	
	Rest	7.58	14	0.54	17.49***

*** - significant for P<0.001

Significance of multiple regression was established by the test F. Thus, the variances determned by the experimental factors are significant (P<0.001) for both seed viability and catalase activity.

These data are additionally confirmed by the multiple correlation and determination coefficients between the parameters analysed and the two experimental factors (Table 2).

Table 2. Multiple correlation coefficients (M) and determination coefficients (D) between the parameters analysed and the experimental factors

Parameters	M	D
Seed viability	0.882***	0.779***
Catalase activity	0.928***	0.861***

*** - significant for P<0.001

A strong correlation between seed viability and activity of catalase was estimated (r = 0.879; P<0.001). The regression line for this correlation points out the rate of modifications in catalasic activity depending on the viability of maize seeds submitted to accelerated ageing (Figure 1).

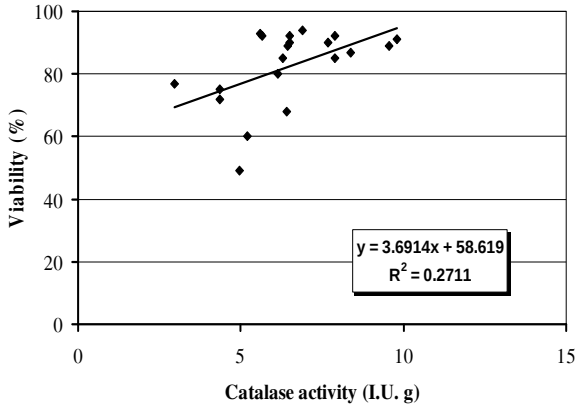

Figure 1. Regression line for viability depending on catalase activity in maize seeds submitted to accelerating ageing

Simple correlation coefficients and the corresponding regressions resulted in three constants for each parameter (Table 3). This mathematic model was applied to all 20 combinations of treatments for both viability and catalase enzymatic activity.

Table 3. Constants of seed viability and catalase activity for maize seeds

Parameters	K_V	C_1	C_2
Seed viability	83.63	1.371	0.175

Catalase activity	9.87	0.162	0.020

Graphic projection of the values for viability (Figure 2) and for catalase enzymatic activity (Figure 3) showed a strong relationship between the values of viability and catalaze enzymatic activity, rezulted from germination test and biochemical analysis respectively and the corresponding values estimated

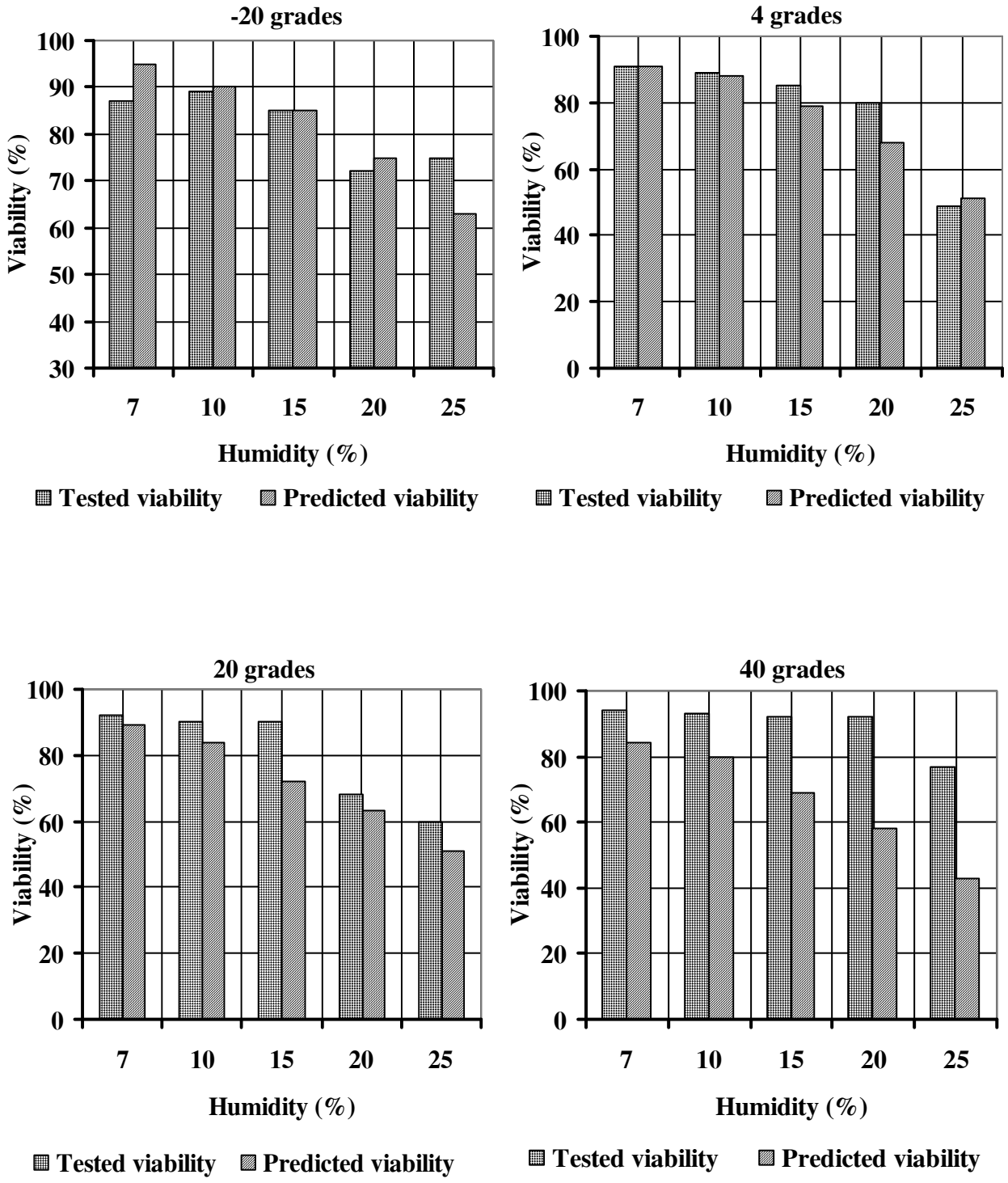

Figure 2. The values of maize seed viability determined parallelly by testing and by predicting with the basic regression equations

with basic equations.Values obtained by testing and predicted by equation are very close for the moisture levels of 7%, 10%, 15% and 20%. Only for moisture level of 25% a more consistent difference was registered. Very small differences between the observed and predicted values were obtained for al moisture levels at the temperature of 4°C and 20°C while at 40°C, the differences were more consistent for all moisture levels.

At extreme temperature limits, -20°C and 40°C, large differences between the observed

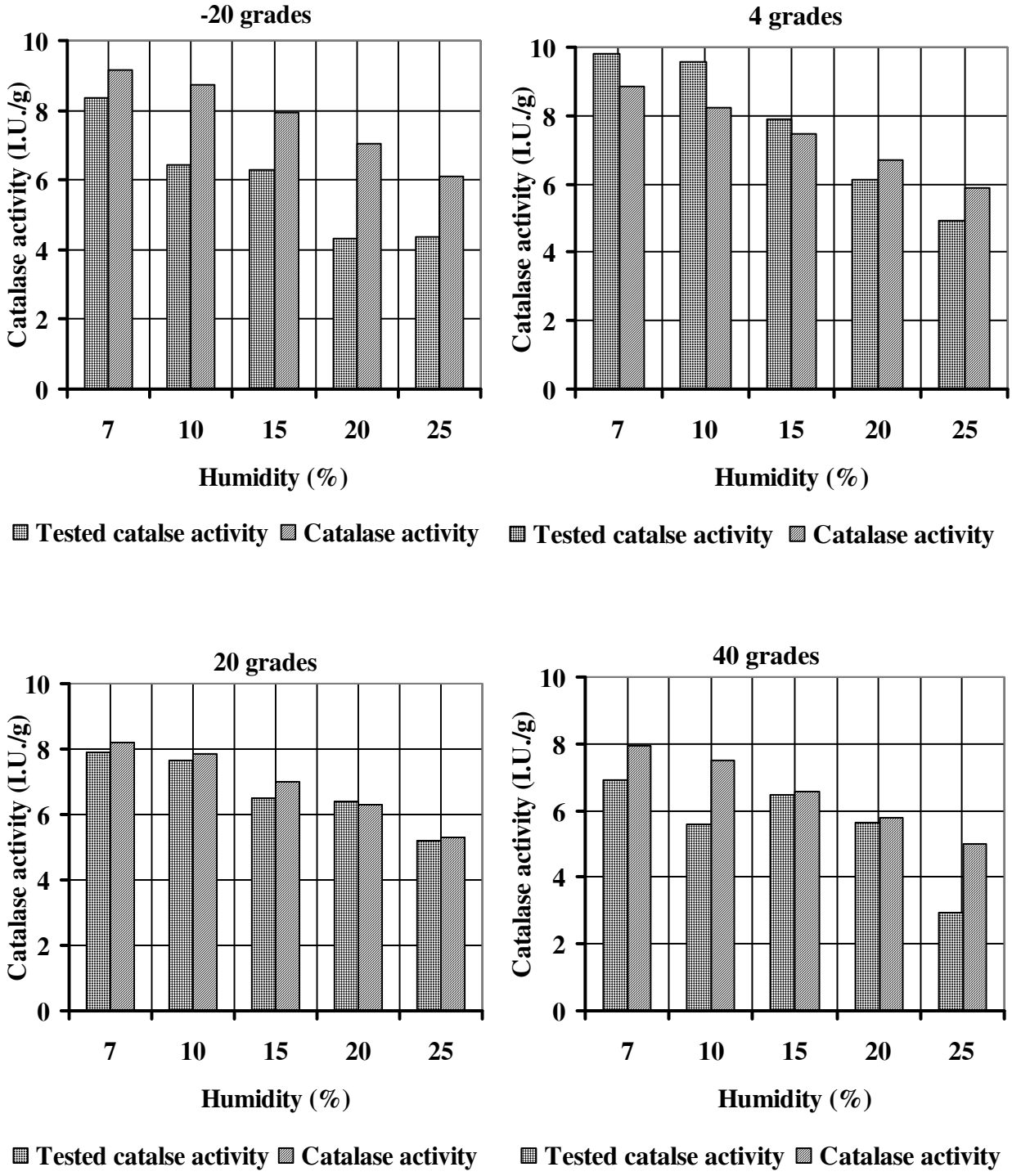

Figure 3. The values of maize seed catalase activity determined parallelly by testing and by predicting with the basic regression equations – I.U. = International Units

values for catalase activity and those predicted were recorded, while at 4°C and 20°C the same differences were non-significant.

CONCLUSIONS

The values for viability, obtained by laboratory germination tests, were very close to the values predicted by basic regression analysis only for temperature levels of 4°C and 20°C. At the level of 40°C, the basic regression equation did not estimate correctly the seed viability.

The values for catalase enzimatic activity determined biochemically in laboratory fitted well to predictions made by basic regression equations only at 4°C and 20°C. At -20°C and 40°C the prediction was much less efficient. Predicting seed viability and catalasic enzymatic activity for maize seed preserved in gene banks has the advantage that seed samples with low viability might be identified only determining the catalasic activity in very small seed samples (10-15 kernels).

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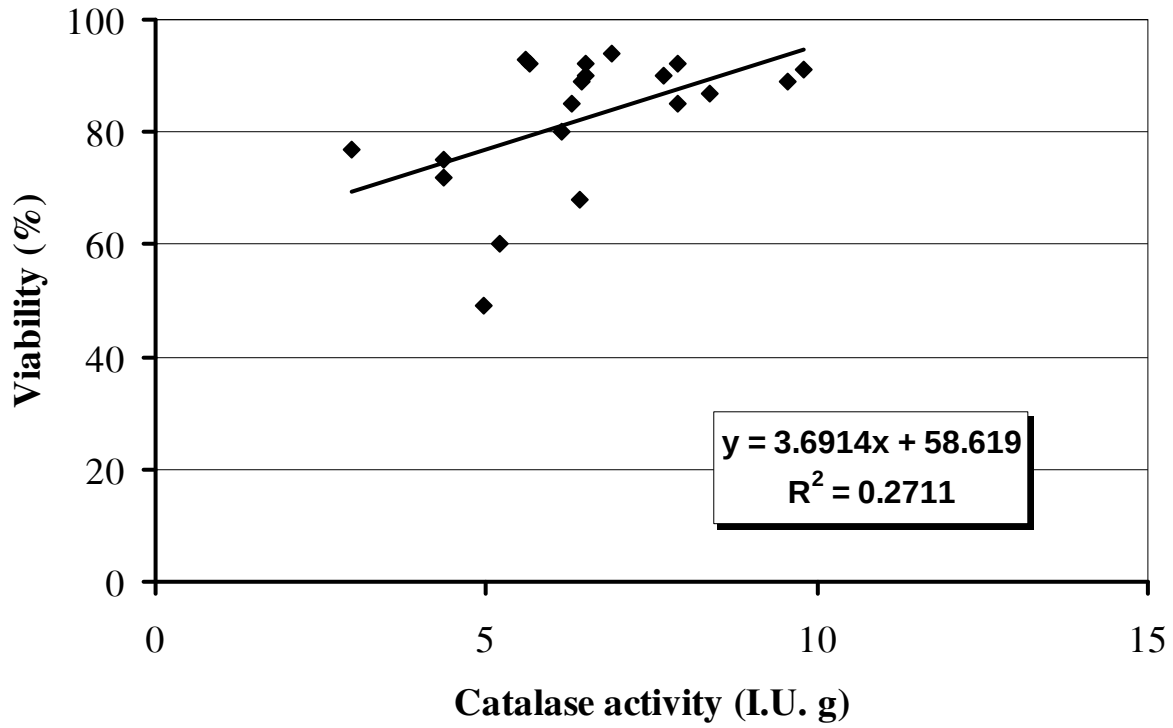

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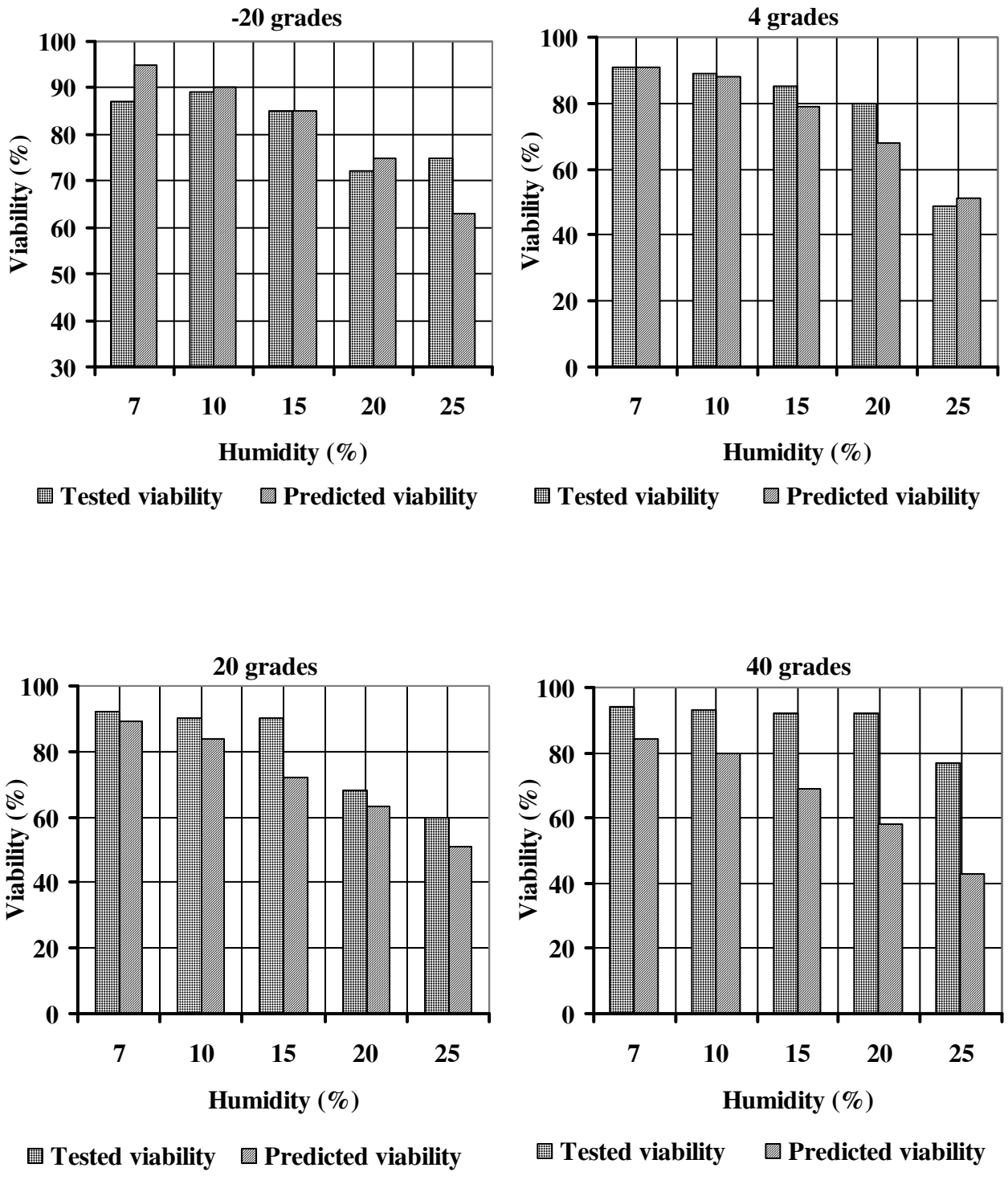

Figure 2. The values of maize seed viability determined parallely by testing and by predicting with the basic regression equations.

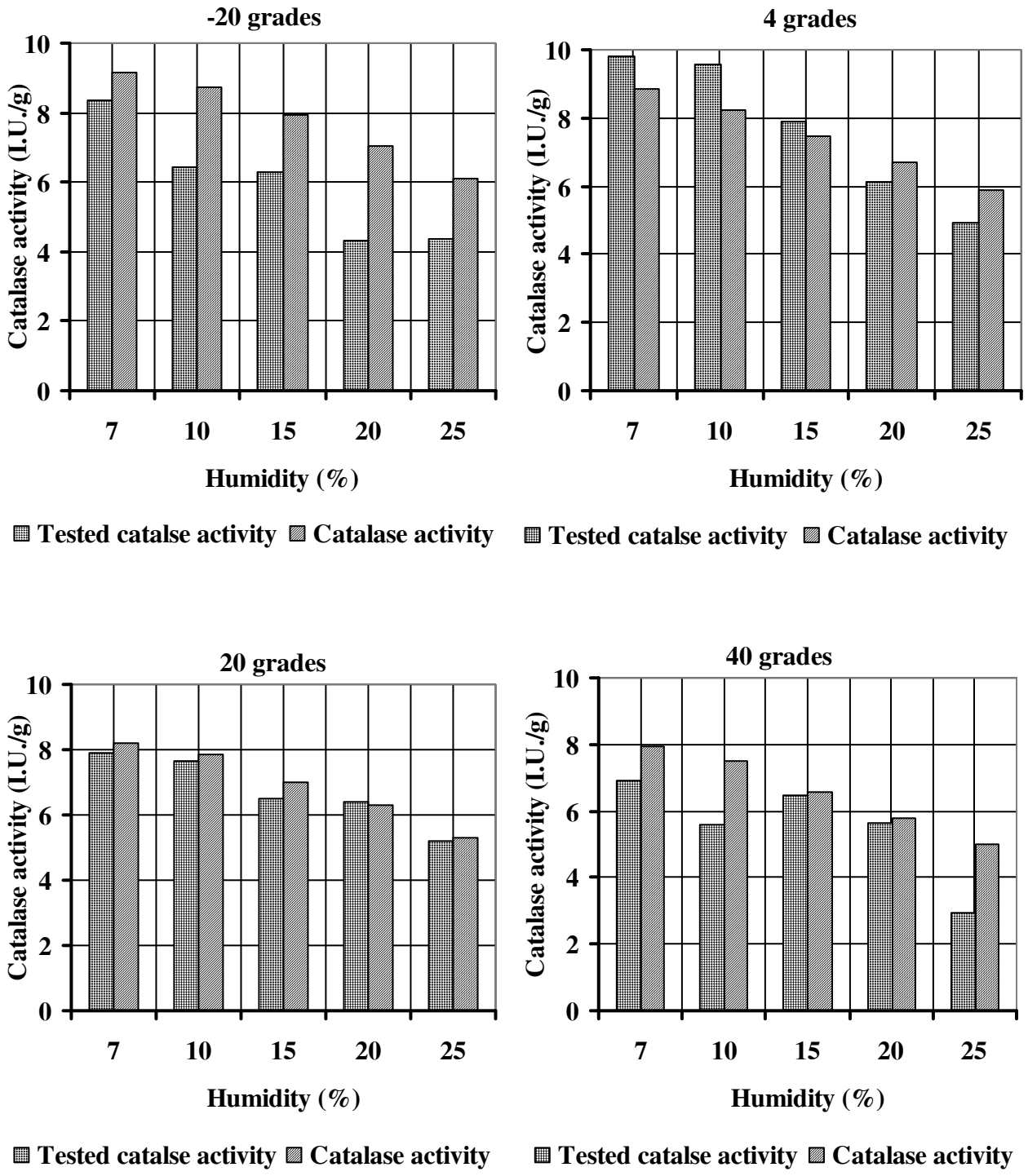

Figure 2. The values of maize seed catalase activity determined parallely by testing and by predicting with the basic regression equations – I.U. = International Units.