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GENOTYPE RESPONSE OF DIFFERENT PEPPER VARIETIES TO THE ACCELERATED AGING TEST OF THE SEEDS

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Abstract

The main goal of the present study was to identify the genotypic response of different pepper varieties to the accelerated seed aging test and to optimize the regimen for this test in pepper. The experiments were carried out with eight varieties of pepper with a different origin. The seeds were subjected to accelerated aging according to the International Seed Testing Association (ISTA) rules. The temperature of 35^{0}C and 40^{0}C and duration of aging from 24, 48 and 72 hours were investigated. The seeds after treatment were subjected to a standard germination test. Initial seed moisture, germination energy, germination, mean germination time and uniformity of germination, fresh and dry weight of one sprout, length of embryo root and hypocotyls were determined. Severe germination suppression was observed at 35^{0}C for 72 hours and at 40^{0}C for 24 hours depending on the variety. Speed and camaraderie have almost doubled at 40^{0}C in 24 hours. The results were compared with non-aging seeds. The best physiological sensitivity was established at 40^{0}C for 24 hours.

Key words*: germination, viability, vigour, sprouts, mean germination time.*

INTRODUCTION

The high quality of seeds is of particular importance for the sustainable development and cultivation of vegetable crops (Peñaloza, 2005). During the storage of seeds, several of physiological and biochemical processes take place in them, which cause their vitality to be reduced (Kaewnaree et al., 2011).

TeKrony (1995) and Torres and Marcos-Filho (2003) emphasize that accelerated aging test is one of the most commonly used method for assessing the physiological potential and seed quality of the seeds.

Information obtained through accelerated seed aging supplement the results of other assessment methods, such as the standard germination test, while at the same time also showing seed performance during storage and field conditions (Almeida et al., 2014). According to Marcos-Filho (1999) and Freitas and Nascimento (2006) the principle of this test is to estimate the intensity and speed of deterioration of the sowing qualities by placing the seeds under stress conditions of high temperature and air humidity, and in the case of lower seeds quality this deterioration occurs much faster. Ferguson-Spears (1995) points out that, after cold test, the accelerated seed aging are the most commonly used method for assessing their vigour.

Demir and Mavi (2008) consider that, among other methods, accelerated seed aging is very suitable for evaluating sowing qualities and longevity in several of vegetable crops. Dutra et al. (2006), who also report that accelerated seed aging is particularly common in evaluating the quality of vegetable seeds. In small-seeded vegetables the water content of the seeds and faster absorption of the water and reaching its maximum content after a much shorter period than filed crops are the main problems which are the cause for the more limited studies of this test.

At the same time, it is a very good alternative for a more complete assessment of the seed (Jianhua and McDonald, 1996). In this sense, Marcos-Filho (1998) also reported that in small seeded crops, further studies are needed to improve the methods of determination vigour, which can be successfully achieved through accelerated aging and its advantages are easy and a quick way for qualification of the seeds.

To classify pepper seeds from individual lots, Panobianco and Marcos-Filho (1998) recommend the application of the accelerated

aging test. Gagliardi and Filho (2011) point out that this test is very suitable for assessing the physiological potential of pepper seeds. One of the most commonly studied factors in the application of the accelerated aging test for pepper seeds is the influence of exposure time at high temperatures (TeKrony, 1995).
The main goal of the present study was to identify the genotypic response of different pepper varieties to the accelerated seed aging test and to optimize the regimen for the test in this crop.

MATERIALS AND METHODS

The experiments were carried out in the experimental field of the Department of Horticulture at the Agricultural University-Plovdiv, Bulgaria with the following varieties, with the corresponding humidity indicated in the brackets Jalapeno (8.8%), Dzhulunska shipka 1021 (8.6%), Wulkan (9.2%), Picante de Cayene (10.4%), Romanian Giallo (10.1%), Padron (9.8%), Pyramid (10.6%) and Beros (9.4%). The seeds were produced in the field of the Horticulture Department from original sowing material provided by the seed companies.
The standard Bulgarian technology for middle early field production was applied, with sowing on March 15 and planting on May 20 according to the 60 x 15 cm scheme. In the complete botanical maturity phase, the fruits were harvested and the seeds were extracted and dried to the moisture that cover the requirements of ISTA (2013), as it was above mentioned.
The initial moisture content of the seeds was pre-determined using the method described in ISTA Rules (2013). The seeds of all varieties were placed for accelerated aging according to the method described by ISTA (2013). Temperatures of 35^0C and 40^0C and duration of 24, 48 and 72 hours were tested. The seeds by 4.0 g of each variety were placed in a lid-closed box of the following dimensions 11 × 11 × 3.5 cm for length, width and depth, respectively. Distilled water from 40.0 ml was added to the bottom of the box. The seeds were placed on a pre-assembled plastic mesh with measures 10 x 10 cm at a height of 3 cm from the bottom. The boxes thus prepared were kept in a water-jacketed ageing chamber at the temperatures and processing times indicated above.

Immediately after accelerated aging was completed within one hour, the seeds were subjected to a standard germination test in four replicates according to the method of ISTA (2013). First count and final count were determined in 4 replicates using the method described in ISTA (2013). Mean germination time by method of Battle and Whittington and uniformity of germination by method of Strona, both described in Panayotov (2015)
were established.
At the time of germination account, the length of the embryo root and hypocotyls were measured on ten seedlings from each replicates as well as the fresh and dry weight of a seedling. The seedlings dry weight was determined by the method described in Georgiev et al. (1980). The disperssion analysis of data (ANOVA) were processed (Foel and Cohen, 1992)

RESULTS AND DISCUSSIONS

The most of the tested varieties there were relatively good initial germination energy, from 35.3% to 87.3%, for Romanian Giallo and Jalapeno respectively (Figure 1). High values were also account for Dzhulunska shipka 1021 (85.3%) and Padron (83.3%). Silva and Vieira (2006) consider that germinating energy data provide information on seed vigour, adding that the deterioration of seeds may first be detected much earlier from changes in germination energy than in germination.
Accelerated seed aging causes significant changes in this indicator yet in the first treatment period of 24 hours at 35^0C. The highest decrease in comparison with control was observed for the seeds of the Pyramid variety - with 49.02%, followed by those of Romanian Giallo - with 37.68%. Both varieties have low initial germination energy. According to Torres and Marcos-Filho (2003), low-quality seeds deteriorate much stronger and faster than higher-quality one.Very close to the initial, remains the germination energy at Jalapeno and Beros, as well as for Dzhulunska shipka 1021. The deterioration is also significant at 48 and 72 hours, especially for the Wulkan and Romanian Giallo. A temperature of 40^0C leads

to an even greater reduction in germination energy, as early as 48 hours it is zero for the seeds of Jalapeno and Pyramid, and at the next 72 hours exposure no germinating seeds were found in almost all the varieties tested. At this temperature for 24 hours, high values still show Dzhulunska shipka 1021, Padron and Jalapeno, i.e., seeds with high initial germination energy. Similar are the observations of TeKrony's (2003), according to him the initial seed status determines the strength and intensity of the accelerated aging effect.

All varieties included in the experiment there were very high germination, except for Romanian Giallo, as the values ranging from 81.6% for Picante de Cayene to 94.7% for Jalapeno and Padron. Compared to these data, as a result of accelerated aging at 35^0C for 24 hours the Wulkan deteriorated by 26.7%, followed by Picante de Cayane by 16.9% and Beros by 15.3%. In the next two exposures, as well as for 24 hours at 40^0C, only the Dzhulunska shipka 1021 and Padron retain good germination. The deterioration at 24 hours/40^0C is very strong, especially for Pyramid and Jalapeno, with 77.0% and 67.4% respectively of the initial germination. At this temperature for 72 hours of aging, only the seeds of Dzhulunska shipka 1021 retained acceptable germination, although not by the standard, with a reduction of 36.6% than non-aging seeds. This indicates that these seeds are with good storability and longevity, which is possibly related also with their higher vigour.

In most of the varieties there is also a complete loss of germination and lethality of the seeds. The sharp deterioration, but with a very well pronounced difference between the separate varieties and the ability to clearly highlight the samples with high vitality and vigour, is established at 40^0C for 48 hours. This gives reason for recommending a temperature of 40^0C with duration of 48 hours as an appropriate regime, with good physiological sensitivity for conducting the accelerated aging test of pepper seeds. This regime indicates very well the high seed potential of the Dzhulunska shipka 1021, Padron, Wulkan and Beros varieties.

In the previous exposure, severe deterioration was also observed, but the variability between the variants was lower and at the highest duration of 72 hours lethality was observed in many samples. Similar parameters for a suitable regimen for accelerated aging of pepper seeds have been reported by other researchers, such as Bhering et al. (2006), Gagliardi and Filho (2011) and Silva da et al. (2018). Serious deterioration of pepper seeds during accelerated aging was also observed by Kaewnaree et al. (2011), emphasizing that this is primarily due to lipid peroxidation and damage to cell membranes, which is associated with increased electrolyte leakage and inability to protein transport.

Zhang et al. (1999) and Tang and Song (1999) also point out as one of the main reasons for the deterioration of the seed quality in accelerated aging are the lipid membrane peroxidation and damage of biomembrane integrity. Statistical significance of the established results except for the variants for 74 hours at 40^0C has been established.

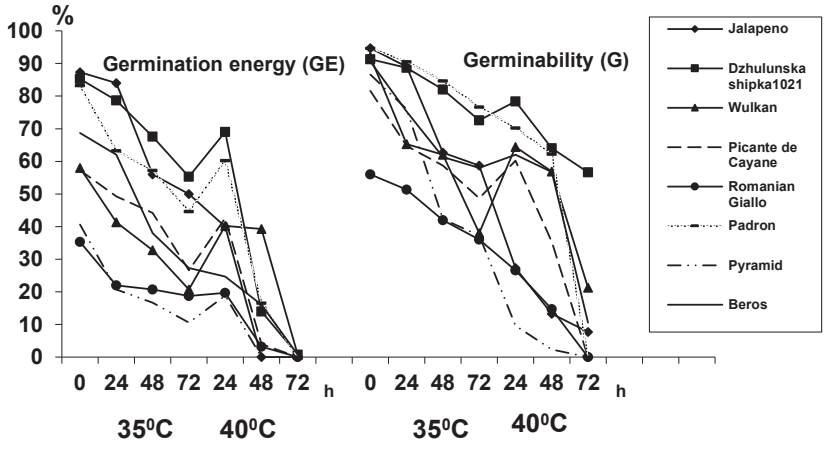
Kapoor et al. (2010) and Rastegar et al. (2011) reported that accelerated aging causes an increase in mean germination time. The initially mean time for seed germination of the tested varieties is between 3.0 (Jalapeno) days to 5.93 days (Romanian Giallo) (Figure 2). After 24 hours at 35^0C, the required germination time increases by approximately one day. The slightest changes are in the Romanian Giallo and Padron varieties, and the strongest one are in the Picante de Cayene.

With increasing temperature and treatment time mean germination time increases steadily, although at a slower rate to reach an increase at 40^0C/72 hours between 3 and 4 days while for Jalapeno variety even more - 7.7 days compared to untreated seeds.

The uniformity of germination as a result of stressful conditions in accelerated aging decreases. The control values of the Dzhulunska shipka 1021 (16.7%) and Jalapeno and Padron varieties with 14.6% and 13.4%, respectively are characterised with the highest values.

After their placement at 35^0C for 24 hours, this indicator is most strongly affected about Picante de Cayene. Relatively high values at 40^0C/72 hours are maintained at Dzhulunska shipka 1021. A strong decrease is observed at 40^0C/48 hours, but in this regime, both mean germination time and uniformity also have the

best physiological sensitivity. Tores and Marco-Filho (2003) emphasize that accelerated aging is of particular importance for the correct evaluation of individual lots. According to Tomes et al. (1988) the effect of temperature compared to aging time has a stronger suppressive influence. The data for these two indicators are with statistical significance except for those for the uniformity of a variety Beros at 40^0C in 72 hours.



LSD p=5%

GE	35^0C			40^0C			G	35^0C			40^0C		
0	24	48	72	24	48	72	0	24	48	72	14	48	72
4.4	3.8	4.1	3.5	5.2	4.8	2.2	3.1	2.6	3.0	3.2	4.3	3.6	5.1

Figure 1. Germination behaviors of pepper seeds after accelerated aging

In addition to vitality, the accelerated aging strongly influences the morphological development of the sprouts. One of the most important indicators related to vigour is the fresh weight of a sprout (Copeland and McDonlads, 2003).

The highest initial fresh weight (Figure 3) was developed by the Jalapeno varieties (82.1 mg) and the lowest one by the Wulkan variety (47.9 mg). With the lightest aging regime of 35^0C/24 hours, the changes are relatively small. A greater decrease was observed only in the Pyramid variety - by 13.0 mg.

With an increase in aging time of 48 hours, the deterioration is more significant. At 72 hours, fresh weight decreased from 22.87% for the Beros variety to 56.1% for Pyramid compared to the control. This characteristic is much lowers at a temperature of 40^0C at 48 hours and as significantly larger stands the weight of sprouts of Jalapeno variety, while the values for the other genotypes are much smaller. This trend is also maintained for 72 hours.

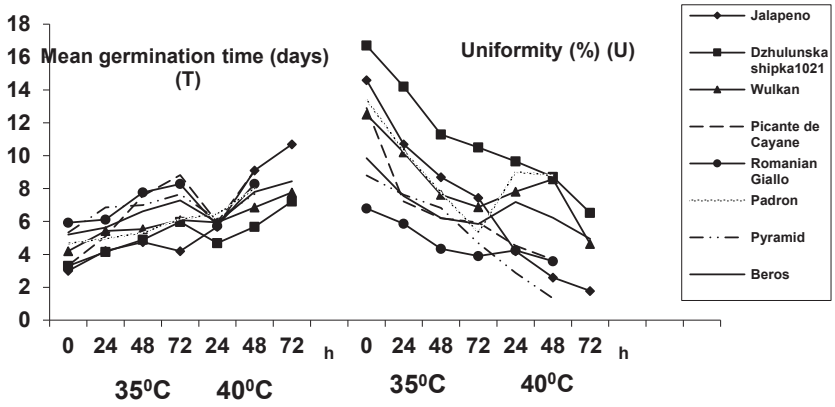
The effect of accelerated aging is very clear also on the accumulated dry weight of sprouts. Deterioration was detected even at 35^0C/24 hours, the highest for the Jalapeno variety- with 39.0%, compared to the control and the lowest one for Romanian Giallo and Pyramid, by 17.2% and 19.1%, respectively. With increasing the temperature and aging time, the deterioration processes increase steadily and by 72 hours at 40^0C the dry weight is more than 50% lower than the control.

The differences for the fresh and dry weight with the controls are mathematically proven, except those of the Beros variety for the $72/40^0$C and the Dzhulunska shipka 1021 variety for the dry weight under the same regime.

The effects of stress conditions from accelerated aging are also found on the length of the embryo root (Figure 4). A decrease is reported at both tested temperatures over a 24-hour period, although differences between controls and between varieties are not well demonstrated. It is stronger for the next 48

hours, especially at 40^0C. In this regime, as well as at 35^0C for 72 hours, the physiological sensitivity to accelerated aging, expressed in more significant varieties differences, is much clearer and well noticeable. At 40^0C/72 hours the values are insignificant.

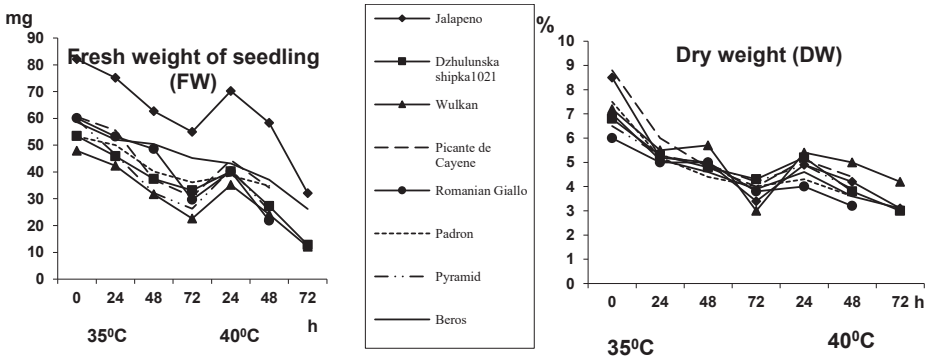
The tendency for the length of the hypocotyls is similar, as the degree of deterioration being stronger. A greater reduction at 35^0C/24 hours is established for the Jalapeno variety. Varietal differentiation is more significant at 35^0C/72 hours and especially at 40^0C/48 hours. This once again indicates that the 40^0C/48 hour regime is suitable to be applied to evaluate the potential, vigour and the storability of pepper seed lots.



LSD p=5%

T	35⁰C			40⁰C			U	35⁰C			40⁰C		
0	24	48	72	24	48	72	0	24	48	72	14	48	72
1.1	1.6	2.0	1.8	1.0	0.7	1.6	1.9	1.6	1.4	2.2	1.9	2.3	2.9

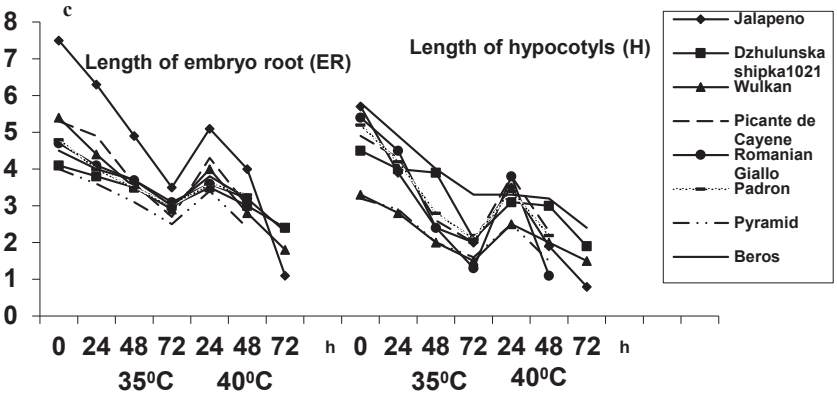
Figure 2. Sowing characteristics of pepper seeds after accelerated aging



LSD p=5%

FW	35⁰C			40⁰C			DW	35⁰C			40⁰C		
0	24	48	72	24	48	72	0	24	48	72	14	48	72
6.4	5.1	4.8	7.2	8.9	5.4	8.8	1.2	0.9	1.6	0.4	0.6	0.5	0.9

Figure 3. Development of pepper seedling after accelerated aging test of the seeds



LSD p=5%

ER	35⁰C			40⁰C			H	35⁰C			40⁰C		
0	24	48	72	24	48	72	0	24	48	72	14	48	72
0.9	1.3	1.2	0.8	1.5	1.0	1.5	1.1	2.0	1.4	1.9	0.9	1.6	1.1

Figure 4.Morphological characteristics of pepper seedling after accelerated aging of the seeds

CONCLUSIONS

Using of the accelerated seed aging test, accurate assessments of the vital status and the storability of individuals lots of pepper seeds can be successfully carried out and classified in descending order.

The highest viability potential and storability respectively, after application of the accelerated aging test, demonstrated the seeds of the varieties Dzhulunska shipka 1021 and Padron, followed by those of Wulkan and Beros.

Depending on the applied regime - temperature and time of impact, the sowing qualities of pepper significantly reduced, but a strong deterioration is also observed on the morphological development of the sprouts.

The most accurate estimation of the potential, vigour and storability of pepper seeds and a high physiological sensitivity in the same time are achieved by applying accelerated aging regime form 48-hours at 40^{0}C.

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