Improving the vigor of traumatized sesame seeds with the help of potassium nitrate at different germination temperatures

Petar Chavdarov, Stanislav Stamatov
Agricultural Academy, Institute of Plant Genetic Resources – Sadovo, Bulgaria
E-mail: *stanislav44@abv.bg*

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Abstract
The influence of 0.2% potassium nitrate solution and different temperature regimes on vigor of traumatized sesame seeds was tested. The vigor of the seeds was measured on the third day and was significantly increased in the variants in which we use a solution of potassium nitrate. The increase in these variants is over 50% compared to the control and its value reaches 61%. The two tested factors (temperature and potassium nitrate solution) influence the increase of germination energy. It is more pronounced with potassium nitrate. The optimal temperature for the vigor of the seeds is in the range of 27 to 28 ºC.

Key words: sesame; seeds; vigor; potassium nitrate; temperature

INTRODUKTION

Sesame is an oil-bearing crop and as such, any damage to the integrity of the seeds causes the separation and oxidation of the oil. This leads to a decrease in their vitality and germination (Oyekale et al., 2012). When threshing the seeds, as a result of the impact of the threshing drum on them, microinjuries occur. As a result of the traumatized, the seed germ is damaged (Stamatov & Deshev, 2018). The main purpose of testing the sowing qualities of seeds is to avoid planting seeds that do not have the ability to grow as normal plants. The germination test is one of the methods for providing information to seed users on the ability of seeds to grow as productive plants under optimal environmental conditions.

The test that gives the best assessment of seed quality is the vigor test. Seed vigor assessment can be interpreted as a series of traits that indicate seed activity so that they can grow in a wider range of field conditions (ISTA, 2014). High-viability seeds can grow in suboptimal environmental conditions and produce yield. In addition, seeds with high viability grow faster because they require a short time to germinate (Sadjad & Ilyas, 1999). One parameter of seed value is the maximum growth potential. The value of maximum growth potential indicates high seed vigor (Sutopo, 2004).

Surface-applied on seeds nitrogen compounds are effective substitutes for the plant growth substance. Seeds of many crops and tree species show increased levels of vigor and germination of seeds when treated with potassium nitrate solution (Beligni & Lamattina, 2000; Bethke et al., 2004; Gniazdowska et al., 2010; Bian et al., 2013).

Temperature is a very important factor for seed germination and its optimum is different in different plant species (Kim et al., 2016). There are insufficient studies on how different temperatures affect sesame seed germination (Canadell et al., 1991). According to Kyauk et al. (1995), any increase in temperature above 20°C causes an increase in the germination of sesame seeds.

The aim of the study is to determine the influence of potassium nitrate on the vigor of traumatized seeds at different temperature regimes and to determine the most favorable temperature regime for maximum seed vigor.

MATERIAL AND METHOD

Seed material

The seeds used in this study were of the Nevena variety harvested with a combine harvester. Embryo damage is shown in figure 1.

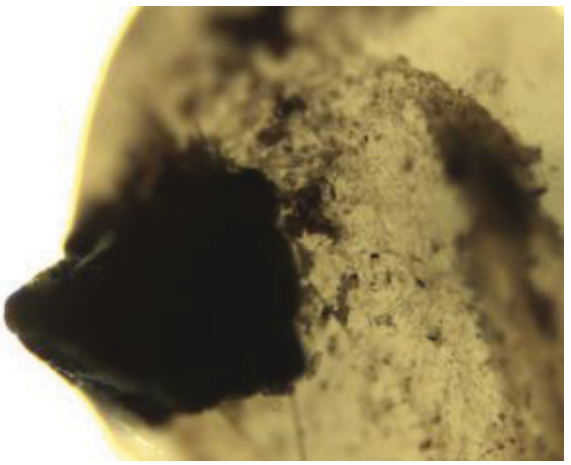

Figure 1. The embryo damage

Seed germination test

A standard seed germination test was used, in which they was placed in a container lined with filter paper (ISTA, 2014).

Experiment design

The experiment was performed in triplicate for each variant, testing the germination of 100 seeds. The filter paper is moistened with 15 ml of distilled water in the control variants. To test the effectiveness of potassium nitrate, the filter paper is moistened with 15 ml of 0.2% potassium nitrate solution. Four temperature regimes were tested, respectively 20, 25, 30 and 35 ºC. On the third day, the seeds germinated with healthy and fully developed sprouts formed the value of the vigor.

Statistical methods

The strength of the influence of potassium nitrate and the different temperature regimes on the vigor of the seeds was established by means of two-factor dispersion analysis. To determine the most appropriate temperature at which potassium nitrate-treated seeds have the highest germination energy, the least squares method calculated using polynomial regression techniques is used (Gergonne, 1974; Yin-Wen Chang et al., 2010).

RESULTS AND DISCUSSION

The vigor of the seeds from all control variants is very low (Table 1). It has the lowest value at 20ºC germination temperature, and the highest at 25ºC. Highest vigor is sesame seeds germinated at temperatures between 25 and 27ºC (Olosunde et al., 2018). The vigor of the seeds increases significantly when they germinate in 0.2% potassium nitrate solution. In all variants, it exceeds 50% and reaches 67% at germination at 25ºC.

Table 1. Seeds vigor

Temperature, °C	Germination, %		Increase compared to control, %
	Control	KNO_3	
35	25	63	60,3
30	30	65	53.8
25	32	67	52.2
20	23	59	61,0

KNO_3 – (Potassium nitrate)

The research of a number of authors also achieve a significant increase in seed germination when using potassium nitrate (Zavariyan & Asghari., 2015; Anisa Ruttanaruangboworn et al., 2017; Muhammad Moaaz Ali et al., 2020).

The influence of both factors (temperature and potassium nitrate) on the increase of vigor in seeds is shown in Table 2. The results show that both tested factors affect the vigor of seeds. However, the standard deviation of the temperature factor is lower than that of potassium nitrate. Its influence is clear in the direction of increasing seed vigor. The results of Kyauk & Brigham (1995) are similar, the authors show a stronger effect on the germination energy of germination stimulators before the temperature factor.

The optimum temperature for vigor of sesame seeds was calculated using a polynomial equation. The curve in figure 2 shows that the seeds will have the highest vigor at temperatures between 27 and 28ºC.

Table 2. Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	Temperature	161.583[a]	3	53.861	22.287	.000
	KNO_3	119.000[b]	3	39.667	52.889	.000
Intercept	Temperature	8802.083	1	8802.083	3642.241	.000
	KNO_3	48387.000	1	48387.000	64516.000	.000
VAR00001	Temperature	161.583	3	53.861	22.287	.000
	KNO_3	119.000	3	39.667	52.889	.000
Error	Temperature	19.333	8	2.417		
	KNO_3	6.000	8	.750		
Total	Temperature	8983.000	12			
	KNO_3	48512.000	12			
Corrected Total	Temperature	180.917	11			
	KNO_3	125.000	11			

a. R Squared = .893 (Adjusted R Squared = .853)
b. R Squared = .952 (Adjusted R Squared = .934)

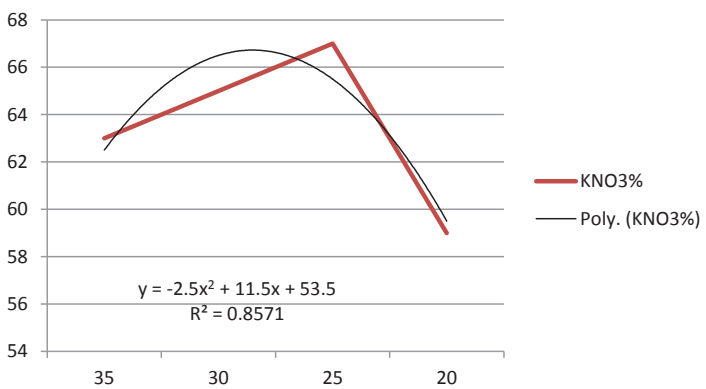

Figure 2. Polynomial curve for increasing vigor of the sesame seeds at different temperature regimes

CONCLUCIONS

1. Sesame seeds traumatized by the threshing machine has reduced its vigor.

2. Potassium nitrate is able to increase the vigor of sesame seeds by more than 50%.

3. The optimum temperature for germination of sesame seeds is between 27 and 28ºC.

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