THE INFLUENCE OF SOME TANNIN EXTRACTS ON THE WHEAT GRAINS VIGOR

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The article presents data about the action of the tannin extracts (oxidized and intact) from oak bark, commercial black tea, grape seeds on some characters of growth and development of common autumn wheat plants at an early ontogenetic stage. It was found that the extracts did not show toxicity in the used concentrations (0.00125… 0.01%). The variants that stimulated the germination, the seedling length were established, which led to the increase of the vigor of the wheat grains and dry mass *per* plant. By factor analysis was established the decisive role of wheat genotypes in the reaction to treating grains with aqueous extract solutions. The cluster analysis made possible the identification of the cluster of substances that have a stimulating influence on the vigour index of wheat grains.

Keywords: wheat, genotype, tannin extracts, stimulation, seed vigor.

INTRODUCTION

Food security depends in the most direct way on the performance of the seed industry. According to recent data, the global seed market is about $ 54 billion (ISF, 2016). In the interior market, the largest seed market is in the US ($ 14 billion), followed by China ($ 11.9 billion), France ($ 3.4 billion), Brazil ($ 3.1 billion), Canada and India (each 2.5 billion, USD). Many countries are based on imports to meet their seed needs (ISF, 2016). In the last 50 years, there have been 1–3% annual increases in seed crops worldwide in the most important crops, which are due to the involvement of genetic methods in breeding programs and optimization of specialized management systems (Bruins, 2009).

However, obtaining high and quality crops is endangered as climate change in recent decades poses more challenges and fluctuations in temperature, humidity, CO_2 and have a direct impact on soil and plants (Singh, Prasad, Reddy, 2013). Rising temperatures can decrease seeds mass due to an accelerated seeds growth

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rate and shorter filling time (Gibson, Paulsen, 1999; Young, Wilen, Bonham-Smith, 2004), although lower seeds mass does not necessarily reduces seeds germination or vigor.

High temperature stress, before the seeds reach physiological maturity, can reduce germination by inhibiting the plant's ability to provide the assimilates to synthesize the reserve substances needed for the germination process (Hampton *et al.*, 2013), which is why the seeds bears physiological disturbances (Powell, 2006). In the context of those mentioned, there is the opinion that a primary requirement for newly created varieties would be a seed with good performance, ie with high vigor even in unfavorable conditions (Pazderu, 2009).

In soybean cultivation, one of the effective agrotechnical measures used to increase the vigor of seeds is their treatment with biologically active substances (Taylor, Harman, 1990) – various growth regulators, enzymes, substances associated with plant bioenergetics or photosynthetic pigments (Drimalova, 2005). Some biologically active substances, such as compounds based on a mixture of synthetic auxins, humic acids and fulvic acids, have a beneficial effect on seeds germination and the subsequent growth of soybeans.

During vegetation, treated plants are more resistant to stress, which often manifests itself in the form of insufficient humidity or extreme temperature (Egli *et al.*, 2005; Anuradha, Rao, 2007). At the same time, high-vigor seeds are more resistant to stressful conditions and age more slowly than low-vigor seeds. Thus, the seed vigor is also a durability test index for soya (Tekrony, 2003).

The use of synthetic biologically active substances to increase the germination of the seeds from different species has a wide applicability, however it is quite often restricted due to the high cost price and unwanted side effects. Starting from those mentioned, lately the attention is focused on the creation and involvement in the field of phytotechnics of preparations of plant origin, especially those of tannin origin (Lupascu, Duca, Lupascu, 2010).

The aim of the present research was to establish the action of tannin extracts of different plant origin on the vigor grains of common winter wheat.

MATERIAL AND METHODS

As research material served: 1) 3 perspective lines of common winter wheat – L SBS, L 1.3 / M and L M / M3; 2) tannin extracts – 3 oxidized (obtained from oak bark (OE), commercial black tea (BT), grape seeds and an intact grape seed (non-oxidized) called Enotanine (ET). The oxidized grape seed extract has the name Enoxyl (EX).

It should be noted that wheat grains were harvested from the 2020 harvest, when in the Republic of Moldova autumn cereal crops grew and developed in unfavorable conditions – snowless winter and dry spring, the rains occurring only in May. According to the data from Tab. 1–3, grain germination at the genotypes studied varied within the limits of 58.4… 89.0%. Considering that in the years with favorable conditions the germination of these genotypes was at the level of 95–100%, we can conclude that the conditions in 2020 significantly affected some genotypes, in our case – L 1.3 / M (58.4%).

The treatment of the grains was carried out by soaking them for 6 hours in aqueous solutions of tannin extracts in concentrations 0.00125; 0.0025; 0.005; 0.01%. After treatment, the grains were dried in the open air at room temperature for 24 hours, then placed in Petri dishes between 2 sheets of filter paper, moistened with distilled water and kept at a temperature of 19–20°C for 6 days.

The experiment was made in 3 repetitions, 30 grains each. The following parameters were assessed: grain germination (%), seedling length (cm), vigor index (germination, % x seedling length, cm), dry mass *per* seedling (mg).

The obtained data were processed by applying the method of descriptive statistics, three-factor analysis, cluster (distribution dendrogram, *k*-mean method) in the software package STATISTICA 8.

Tannin extraction methods. To obtain the extracts from the plant material, the static method (maceration and periodic draining) and the dynamic method (ultrasonic field extraction) were used. At the establishing of the optimal parameters of the extraction process, a series of factors were taken into account: solvent concentration, plant product: solvent ratio, extraction duration.

Extraction by mechanical agitation. Initially, the vegetable raw material was prepared for extraction – drying at room temperature and removal of mechanical impurities. The solvent (ethyl alcohol in concentrations of 50 and 70%) was added to the weighed vegetable product in a mass / volume ratio of 1:10 and 1:5, which was then allowed to stir for 24 hours at room temperature (the procedure was performed in three successive stages). The extracts obtained were unified and concentrated by steam distillation produced by Heidolph Instruments GmbH & Co. KG. KG (Germany). The product obtained was dried at 45°C.

Ultrasonic field extraction. The plant product, prepared for extraction and weighed in a ratio of 1:10 and 1:5 with solvent (ethyl alcohol in concentrations of 50 and 70%), was suspended in a water bath and put under ultrasound treatment for 30 minutes at room temperature (the procedure was performed in three successive stages). The extracts were unified, concentrated by steam distillation and dried at 45°C.

Oxidation of tannin extracts. Tannin extracts from oak, tea and grape seeds were oxidized because in the first 2 cases the extracts were insoluble in water, and in the case of Enotanins, although they were soluble in water, the oxidation was performed to make a comparative study of the activity of intact extracts and oxidized. For this purpose, 4 parts of hydrogen peroxide (H_2O_2) were added to one part of the tannins, and stirring and drying took place at 45–50°C for 48 hours. The process for obtaining water-soluble tannins from grape seeds is described in the patent MD 3125 (Lupaşcu, Lupaşcu, 2006).

RESULTS AND DISCUSSIONS

The analysis of the reaction of wheat genotypes to the treatment of grains with aqueous solutions of tannin extracts showed the lack of their inhibitory effects for growth and development in all of the variants, which indicates the lack of toxicity of the studied preparations in the applied concentrations.

Stimulations of the analyzed parameters were found, the effect of which depended on the genotype of the plant, character, extract, concentration. Thus, at the L SBS (Tab.1) line it was a considerable increase of the vigor index (+13.8… + 29.4% in relation to the control) under the influence of oak extracts (0.01%), Enotanins (0.00125%) and Enoxyl (0.00125%). Oak bark extracts (0.01%) and black tea (0.005%) contributed to the significant accumulation of biomass (+16.6… + 16.8% compared to the control).

Stimulation of growth traits has also been reported in the L 1,3 / M genotype in some variants (Tab. 2). It is worth mentioning the Enotanine-0.00125% variant, in which significant increases were found – of 61.6, 18.0, 108.6, 16.7%, respectively, in relation to the control for all the analyzed characters – germination, seedling length, vigor index, dry mass *per* seedling.

If statistically true increases were recorded for the L SBS genotype under the influence of extracts in 11 cases, for L 1,3 / M – in 9 cases, then for the L M / M3 line such effects were found in 17 variants. At the L M / M3 genotype, no effects were observed in the case of oak extracts, instead the genotype responded positively (3 out of 4 characters analyzed) to the treatment with tea extracts in the lowest concentration – 0.00125%. The vigor index increased significantly when treating the grains with Enotanine extract in concentrations 0.00125; 0.0025; 0.01% and with Enoxil in all of the concentrations under study (Tab. 3).

Table 1

The action of tannin extracts on growth and development characters in the wheat line L SBS

Variant	Concentration, %	Germination, %		Seedling length, cm		Vigor index		Dry mass *per* plant, mg	
		$x \pm m_x$	σ	$x \pm m_x$	σ	$x \pm m_x$	σ	$x \pm m_x$	σ
Control (H_2O)	-	88.9±1.1	1.9	12.0±0.2	0.4	1070.1±7.3	12.6	8.39±0.45	0.77
Oak bark extract	0.01	93.3±3.8	6.7	13.1±0.3	0.5	1217.5±33.1*	57.3	9.78±0.09*	0.15
	0.005	92.2±6.2	10.7	11.8±0.6	1.0	1094.7±122.4	212.0	7.69±0.65	0.13
	0.0025	95.6±1.1*	2.0	12.6±0.6	1.1	1209.0±72.8	126.0	9.15±0.06	0.11
	0.00125	97.8±2.2*	3.9	12.7±1.0	1.7	1241.0±110.3	191.0	8.69±0.95	1.65

Table 1 (continued)

Variant	Concentration, %	Germination, %		Seedling length, cm		Vigor index		Dry mass *per* plant, mg	
		x±mx	σ	x±mx	σ	x±mx	σ	x±mx	σ
Tea extract	0.01	95.6±4.4	7.7	12.4±0.3	0.6	1186.7±84.1	145.6	8.71±0.24	0.41
	0.005	91.1±5.9	10.2	13.6±0.1*	0.2	1240.3±76.8	133.0	9.80±0.10*	0.18
	0.0025	95.5±3.0	5.3	11.9±0.4	0.7	1137.4±44.4	77.0	8.02±0.80	1.38
	0.00125	90.0±6.7	11.6	13.5±0.7	1.2	1212.2±78.7	136.3	9.58±0.32	0.56
Enota-nins	0.01	94.4±4.0	6.9	12.6±1.5	2.7	1205.4±188.0	325.6	9.40±0.86	0.50
	0.005	93.3±3.8	6.7	12.4±0.3	0.6	1156.7±60.2	104.2	8.73±0.09	0.16
	0.0025	98.9±1.1*	1.9	12.3±1.7	3.0	1219.3±183.5	317.9	8.58±1.15	1.99
	0.00125	94.4±1.1*	2.0	13.5±0.3*	0.5	1276.2±19.0*	32.9	8.96±0.27	0.47
Enoxyl	0.01	84.5±9.7	16.8	11.0±0.4	0.6	925.2±135.2	234.2	7.32±0.52	0.90
	0.005	77.8±4.5	7.7	12.6±0.4	0.7	974.6±42.9	74.4	8.04±0.47	0.82
	0.0025	96.7±1.9	3.4	12.0±1.2	2.0	1157.7±106.3	184.2	8.30±0.57	0.99
	0.00125	98.9±1.1	1.9	14.0±0.8	1.3	1384.9±59.6*	103.2	9.66±0.16	0.28

*- veridical difference from control, $p \leq 0,05$.

Enoxyl showed a more pronounced positive effect compared to the non-oxidized extract – Enotanin in the case of the vigor index at L SBS in the concentration 0.00125% and the length of the seedling at L M / M3 in all tested concentrations.

Table 2

The action of tannin extracts on growth and development characters in the wheat line L 1,3/M

Variant	Concentration, %	Germination, %		Seedling length, cm		Vigor index		Dry mass *per* plant, mg	
		x±mx	σ	x±mx	σ	x±mx	σ	x±mx	σ
Control (H_2O)	-	58.4±6.7	11.5	13.9±0.3	0.4	742.0±79.6	137.9	10.15±0.44	0.77
Oak bark extract	0.01	63.3±7.4	14.5	13.9±1.1	1.8	884.1±144.2	249.8	9.71±0.91	1.57
	0.005	63.3±13.5	23.4	12.7±0.7	1.3	815.8±189.6	328.5	9.09±0.47	0.81
	0.0025	63.7±13.1	22.6	13.9±0.8	1.4	572.4±271.0	469.3	9.23±0.70	1.21
	0.00125	44.8±11.5	19.9	14.0±1.9	3.2	581.9±95.5	165.5	9.42±1.19	2.07

Table 2 (continued)

Variant	Concen-tration, %	Germination, %		Seedling length, cm		Vigor index		Dry mass *per* plant, mg	
		$x \pm m_x$	σ	$x \pm m_x$	σ	$x \pm m_x$	σ	$x \pm m_x$	σ
Tea extract	0.01	83.8±1.5*	2.6	15.6±0.2*	0.4	1312.0±39.8	69.0	11.12±0.13	0.23
	0.005	88.9±4.9*	8.4	14.7±1.1	2.0	1311.4±149.2*	258.3	10.30±0.73	1.26
	0.0025	63.7±9.6	16.7	12.5±1.5	2.5	823.5±202.6	350.9	9.77±0.16	2.01
	0.00125	79.1±5.8	10.1	13.1±1.3	2.3	1021.3±35.6*	61.6	9.60±0.88	1.52
Enota-nins	0.01	54.0±9.0	15.5	12.8±0.2	0.4	696.9±124.9	216.3	8.22±0.26	0.45
	0.005	72.3±11.0	19.0	14.2±1.3	2.2	1015.8±133.4	231.1	9.38±0.72	1.26
	0.0025	67.8±5.9	10.2	14.5±0.9	1.6	980.4±104.7	181.3	8.83±0.44	0.77
	0.00125	94.4±1.1*	1.9	16.4±0.7*	1.2	1547.8±76.5*	132.5	11.84±0.09*	0.15
Enoxyl	0.01	72.2±11.1	19.2	13.7±0.8	1.4	983.0±150.6	260.8	10.22±0.56	0.96
	0.005	78.5±16.7	28.9	14.8±0.7	1.2	1180.0±283.4	490.8	11.43±0.49	0.84
	0.0025	33.3±1.9	3.3	15.5±1.3	2.2	510.0±18.9	32.7	10.79±1.13	1.96
	0.00125	69.0±15.1	26.1	12.7±1.2	2.0	901.5±269.3	466.5	8.17±1.00	1.74

*- veridical difference from control, p ≤0,05.

Table 3

The action of tannin extracts on growth and development characters in the wheat line L M/M3

Variant	Concen-tration, %	Germination, %		Seedling length, cm		Vigor index		Dry mass *per* plant, mg	
		$x \pm m_x$	σ	$x \pm m_x$	σ	$x \pm m_x$	σ	$x \pm m_x$	σ
Control (H_2O)	-	89.0±4.9	2.8	13.5±0.6	1.0	1199.8±86.5	149.9	10.63±0.65	1.11
Oak bark extract	0.01	97.8±3.9	2.2	14.5±0.3	0.5	1414.6±59.4	102.8	11.43±0.24	0.42
	0.005	95.5±3.9	2.2	14.8±0.2	0.3	1398.3±52.4	90.7	11.91±0.26	0.44
	0.0025	94.4±9.6	5.6	14.7±0.2	0.4	1383.5±75.2	130.2	11.59±0.31	0.53
	0.00125	80.0±10.0	5.8	13.3±1.0	1.7	1067.3±118.0	204.4	9.86±0.86	1.49
Tea extract	0.01	80.0±21.8	12.6	13.4±0.1	0.2	1069.0±164.7	285.2	10.46±0.28	0.49
	0.005	91.1±8.4	4.9	13.8±1.4	2.5	1262.1±163.2	282.7	10.15±0.96	1.67
	0.0025	74.4±27.8	16.0	11.7±1.5	2.6	910.9±266.9	462.2	9.56±1.65	2.86
	0.00125	96.7±3.4	1.9	17.5±0.6*	1.0	1691.7±42.0*	72.7	14.31±0.55*	0.96

Table 3 (continued)

Variant	Concen-tration, %	Germination, %		Seedling length, cm		Vigor index		Dry mass *per* plant, mg	
		x±m_x	σ	x±m_x	σ	x±m_x	σ	x±m_x	σ
Enota-nins	0.01	97.8±3.9	2.2	16.3±0.1*	0.2	1592.0±30.8*	53.3	12.26±0.47	0.82
	0.005	96.5±6.0	3.5	14.6±0.3	0.5	1406.4±75.1	130.1	11.28±0.22	0.38
	0.0025	98.9±1.9	1.1	16.8±0.5*	0.9	1661.7±65.6*	113.6	11.56±0.38	0.66
	0.00125	98.9±1.9	1.1	17.2±0.9*	1.6	1700.3±77.9*	135.0	11.44±0.63	1.10
Enoxyl	0.01	92.2±8.4	4.9	17.4±0.9*	1.5	1606.3±110.1*	190.8	10.99±0.34	0.60
	0.005	91.3±7.6	4.4	18.0±0.4*	0.6	1642.4±59.4*	102.9	13.04±0.14*	0.24
	0.0025	91.1±5.1	2.9	17.2±0.6*	1.0	1569.2±53.9*	93.3	12.38±0.54	0.93
	0.00125	92.2±7.7	4.5	16.7±0.7*	1.3	1545.2±132.9	230.1	12.12±0.65	1.13

*- veridical difference from control, p ≤0,05.

Factor analysis. In order to establish the source of variation of the quantitative characters at the interaction of the plants with several factors, the factorial analysis of the variance is used successfully. Factor analysis is a statistical technique for identifying the basic factors of character variability, determined based on a large number of observed variables, and not only compares differences, but also involves cause-effect relationships (Araújo, 2003; Piepho, Edmondson, 2018).

As it can be seen from the data obtained, the largest share in the source of variation of the analyzed characters was held by the wheat genotype factor, which varied within the limits of 70.19… 85.66% (Tab. 4).

Table 4

Three-factor analysis of the effects of tannin extracts on the treatment of winter wheat

Source of variation	Deg-ree of free-dom	Germination		Seedling length, cm		Vigor index		Dry mass *per* plant, mg	
		SSE	CSV, %	SSE	CSV, %	SSE	CSV, %	SSE	CSV, %
Genotype	2	9624*	82.21	98.61*	71.39	2846012*	70.19	92.06*	85.66
Extract	3	442*	3.78	11.80*	8.54	275093*	6.79	1.11	1.03
Concentration	3	145	1.24	4.02	2.91	175428*	4.33	1.52	1.41
Genotype x extract	6	409*	3.49	9.64*	6.98	304345*	7.51	2.37	2.21

Table 4 (continued)

Source of variation	Degree of freedom	Germination		Seedling length, cm		Vigor index		Dry mass *per* plant, mg	
		SSE	CSV, %	SSE	CSV, %	SSE	CSV, %	SSE	CSV, %
Genotype x concentration	6	396*	3.38	1.27	0.92	132889*	3.28	0.62	0.58
Extract x concentration	9	266	2.27	5.99*	4.34	130667*	3.22	3.88*	3.61
Genotype x extract x concentration	18	282*	2.41	4.46*	3.23	134791*	3.33	4.60*	4.28
Error	96	143	1.22	2.33	1.69	55293	1.36	1.31	1.22

*- $p<0,05$.
SSE – The sum of the squares of the effects, CSV – Contribution to the source of variation.

With a detached difference, the origin factor of the extract was noticed – 1.03… 8.54%, followed by the concentration factor, statistical support for this factor being registered only for the vigor index –4.33%. The share of different types of interactions – *genotype x extract*, *genotype x concentration*, *extract x concentration*, *genotype x extract concentration* varied within the limits of 3.49… 7.51%, 3.28… 3.38%, 3.22… 4.34%, 2.41… 4.28%, respectively. Data are presented for variants with statistical support, $p \leq 0.05$.

It should be noted that although in the case of the vigor index, as well as the other characters, the genotype factor in the reaction to tannin extracts predominated (70.19%), the interactions between the factors involved were quite significant – 7.51, 3.28, 3.22 %, respectively, for *genotype x extract*, *genotype x concentration*, *extract x concentration.* Thus, by the successful choice of tannin preparations and their concentration, the processes of wheat grains treating can be substantially streamlined in order to improve their vigor.

Cluster analysis. This type of analysis is widely used lately in biological research because it ensures the classification of objects into homogeneous groups based on similar responses (Rameeh, 2014).

The dendrogram distribution (agglomerative-iterative method) of tannin extracts in the concentrations used based on the vigor index in 3 wheat genotypes, demonstrated a distribution of the 17 variants under study in different clusters at different levels of aggregation, which reveal significant similarities or differences between the effects of tannin extracts (Fig. 1).

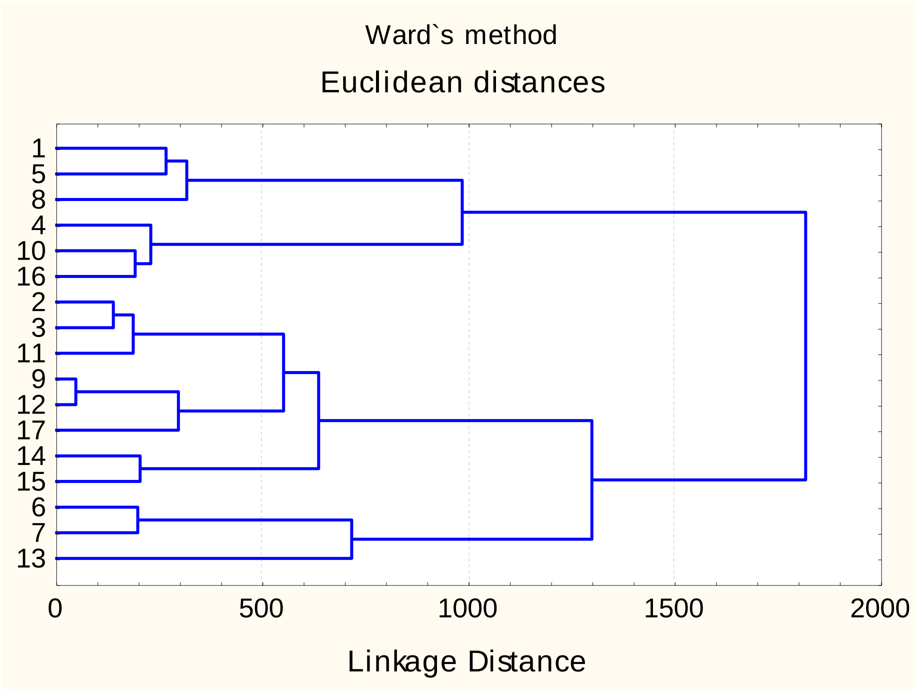

Fig. 1. Dendrogram of tannin extracts distribution based on the grain vigour index.

1 – Martor (H_2O), 2 – OE-0.01%, 3 – OE-0.005%, 4 – OE-0.0025%, 5 – OE-0.00125%, 6 – BT-0.01%, 7 – BT-0.005%, 8 – BT-0.0025%, 9 – BT-0.00125%, 10 – ET-0.01%, 11 – ET-0.005%, 12 – ET-0.0025%, 13 – ET-0.00125%, 14 – EX-0.01%, 15 – EX-0.005%, 16 – EX-0.0025%, 17 – EX-0.00125%.

Unlike cluster analysis based on the distribution dendrogram, the *k*-mean method is a centroid method, the number of clusters of which is at the discretion of the experimenter. According to some opinions, this method has a number of advantages compared to the hierarchical method in object classification operations (Kaushik, Mathur, 2014).

Thus, unlike the L SBS line, in the case of L 1,3 / M and LM / M3 genotypes, the interclusterian variance was much higher than the intracluster variance, which indicates that these 3 clusters programmed according to possible values – small, medium, large were separated well precisely on the basis of these lines which reacted more specifically to tannin extracts (Tab. 5).

Table 5

Analysis of the variance of the tannin extract clusters

Genotype	Interclusterian variance	Df	Intraclusterian variance	df	F	Signification p
1. L SBS	14852.0	2	177240.4	14	0.5866	0.5693
2. L 1,3/M	895332.0	2	403522.2	14	15.5316	0.0003
3. L M/M3	506463.3	2	438230.7	14	8.0899	0.00446

Analyzing the statistical data of the clusters obtained for the vigor index, we found that in cluster 1 the following variants were distributed: 1 – Control, 4 – OE-0.0025%, 5 – OE-0.00125%, 8 – BT-0.0025%, the vigor index mean for 3 wheat genotypes constituting 994.9. Ten variants were located in cluster 2, and the mean of the analyzed parameter was 1202.19 – 20.8% more than in cluster 1. Cluster 3 consisted of only 3 variants: 6 – BT-0.01%, 7 – BT -0.005%, 13 – ET- 0.00125%, and the mean of the vigor index – 1322.87, presented an advantage of 33% compared to the mean of the cluster in which the control was present (Tab. 6).

Table 6

Descriptive statistics for clusters

Case	Mean	Standard deviation	Members of cluster
Cluster 1			
L SBS	1164.38	76.33	1 – Control (H_2O), 4 – OE-0.0025%, 5 – OE-0.00125%, 8 – BT-0.0025%.
L 1,3/M	679.95	123.34	
L M/M3	1140.38	200.53	
Mean	*994.9*	*133.4*	
Cluster 2			
L SBS	1154.82	131.53	2 – OE-0.01%, 3 – OE-0.005%, 9 – BT-0.00125%, 10 – ET-0.01%, 11 – ET-0.005%, 12 – ET-0.0025%, 14 EX-0.01%, 15 – EX-0.005%, 16 – EX-0.0025%, 17 – EX-0.00125%.
L 1,3/M	898.98	188.78	
L M/M3	1552.78	109.70	
Mean	*1202.19*	*143.34*	
Cluster 3			
L SBS	1234.4	45.05	6 – BT-0.01%, 7 – BT-0.005%, 13 – ET-0.00125%.
L 1,3/M	1390.40	136.31	
L M/M3	1343.80	323.48	
Mean	*1322.87*	*168.28*	

So the extracts from commercial black tea and Enotanins, in the concentrations indicated in cluster 3 of Tab. 6 are very effective in treating autumn common wheat grains because they considerably increase one of the basic indicators of quality parameters – grain vigor.

CONCLUSIONS

1. By treating common winter wheat grains with aqueous solutions of oak bark tannin extracts, commercial black tea, grape seeds and Enoxyl (oxidized Enotanine) for 3 hours and assessing the biometric data of the 6-day seedlings, it was found that in the range of concentrations 0.00125; 0.0025; 0.005; 0.01% the extracts are not toxic to plants, and the growth and development characteristics (germination, seedling length, vigor index, dry mass *per* plant) were significantly stimulated under the influence of some treatment variants.
2. The factorial analysis of the variance showed that the highest share in the source of variation of the researched characters belonged to the wheat genotype (70.19 ... 85.66%). It was found that for the grain vigor index was also important the role of interactions *genotype x extract* (7.51%), *genotype x concentration* (3.28%), *extract x concentration* (3.22%), *genotype x extract x concentration* (3.33%), the effect summary of which constituted 17.34%. This indicates that by a successful choice of tannin extracts and concentrations the vigor of the grains can be significantly improved.
3. By cluster analysis (dendrogram, *k*-means) of tannin extracts based on the vigor index of 3 wheat genotypes were found similarities and differences of effects depending on the origin and concentration of the extract. Three extracts were identified – from black tea - 0.005, 0.01% and Enotanin - 0.00125% which registered an advantage of 33% compared to the average cluster at the control level (H_2O).

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