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Journal homepage: asn.shu.bg**Germination of common winter wheat (*Triticum aestivum* L.)
treated with unconventional preparations****Veselin Dochev***Agricultural Institute – Shumen, 3 Simeon Veliki Blvd., 9700 Shumen, Bulgaria*

Abstract: *The study was conducted in the laboratory of the Agricultural Institute of Shumen. The germination energy and germination of winter wheat variety Venka 1 are reported following the adopted methodology. The germination energy was recorded on the fourth day of the experiment, and the germination and measurement of the coleoptile – on the eighth day. 10 granules of the following homeopathic preparations are pre-dissolved in distilled water: Calcium sulfuricum 6 D, Thallium sulfuricum 6 D, Sulfur, Graphites 6 D, Selenium, Ferrum metallicum 10 D, Magnezium fluoratum 10 D, Arsenicum album 12 D, Causticum Hanenmanni 30 D, Zincum metallicum 30 D.*

The tested homeopathic preparations have no proven effect on the germination energy and germination of seeds in wheat variety Venka 1. The variants treated with the homeopathic preparations Thallium sulfuricum and Sulfur have been proven to exceed the standard one in terms of coleoptile length. This work will serve as a basis the study of other homeopathic preparations to determine their impact on uniform germination and their aftereffect on plant growth.

Keywords: germination, wheat, homeopathic elements

Introduction

One of the major trends in agriculture nowadays is the search for new factors influencing plant productivity. One of the promising directions for the increase in plant production is the use of growth regulators and the issue of their application in the production of cereals attracts considerable interest.

A considerable amount of research is being aimed at increasing the vigour and germination of seeds in a number of crops through the use of various chemical and physical methods (Afzal et al., 2016; Lutts et al., 2016; Zheng et al., 2016).

The number of registered biologically active substances used to regulate plant growth and development (Rapparini et al., 1987; Radišič et al., 1997; Sharma and Kumar, 1998), the quantity and quality of the yield (Wu et al., 1993; Vildflush and Gurban, 1999; Taniguchi et al., 1999) increased significantly as well.

The growth and development of plants depend on the intensity of the initial growth of the seeds and their vigour. This affects the uniform germination of seeds and their better utilization of moisture. With good density crop is formed and the competitiveness against weeds increases, which is a prerequisite for higher yields. A close connection between the yield and the sowing qualities of the seeds has been established (Stankov et al., 2010a; Stankov et al., 2010b; Sheveluha, 1992). Sheveluha (1995) found out that wheat yield correlated with germination ($r = 0.87-0.89$), coleoptile length ($r = 0.79-0.84$), and germ root length ($r = 0.64-0.74$).

Pre-sowing treatment of seeds aims to increase germination, uniform germination of seeds, as well as to increase the resistance of sprouts to abiotic stress.

Delchev et al., 2014; Delchev et al., 2015 came to the conclusion that growth regulators increase germination energy and laboratory germination of seeds. It has been established that pre-sowing priming of seeds with growth regulators has a stimulating effect on seed germination in a number of crops (Pourmohammad et al., 2013; Pirasteh-Anosheh et al., 2016; Marinov-Serafimov and Golubinova, 2019).

In the last decade there has been a decrease in micronutrients in crop production. Zn deficiency is considered to be the most common type of micronutrient deficiency in crops and humans (Alloway, 2004; Hotz and Brown, 2004).

Plants grown on soils with low Zn levels exhibit stress from Zn deficiency and contain low levels of Zn in their grain (Graham and Welch, 1996; Cakmak et al., 1999).

Magnesium deficiency in wheat does not affect plant biomass, but affects grain weight (Ceylan et al., 2016).

The aim of the study is to determine the effect of some homeopathic preparations on germination energy, laboratory germination of seeds, and coleoptile length in common winter wheat.

Material and methods

The study was conducted in the laboratory of the Agricultural Institute of Shumen. The germination energy and germination of winter wheat variety Venka 1 are reported following the adopted methodology.

The germination energy was recorded on the fourth day of the experiment, and the germination and measurement of the coleoptile – on the eighth day. 10 granules of the following homeopathic preparations are pre-dissolved in distilled water: Calcium sulfuricum 6 D, Thallium sulfuricum 6 D, Sulfur, Graphites 6 D, Selenium, Ferrum metallicum 10 D, Magneziun fluoratum 10 D, Arsenicum album 12 D, Causticum Hanenmanni 30 D, Zincum metallicum 30 D.

Results and discussion

The research on plant protection reports the use of Sulfur, Ferrum metallicum, Arsenicum album, Causticum Hanenmanni and Zincum metallicum. Some of them, in minimal doses, can provide nutrients to plants.

After reporting the germination energy results, it was established that there was no preparation that was proven to exceed the control one (Table 1). The variants treated with Sulfur, Graphites and Ferrum metallicum showed higher germination energy than the untreated control one, which was not statistically proven. In some of the variants there was a delay in germination, and it was most pronounced in the variant treated with Zincum metallicum. Seed germination was visibly suppressed.

Table 1. Germination energy of Venka 1 wheat seeds, treated with homeopathic preparations

Variants	Mean, number	Difference, number	Significance	Group
Control	42,5			ab
Calcium sulfuricum	30	-12,5	ns	ab
Thallium sulfuricum	35	-7,5	ns	ab
Sulfur	50	7,5	ns	b
Graphites	57,5	15	ns	b
Selenium	12,5	-30	ns	a
Ferrum metallicum	52,5	10	ns	b
Magneziun fluoratum	30	-12,5	ns	ab
Arsenicum album	35	-7,5	ns	ab
Causticum Hanenmanni	40	-2	ns	ab
Zincum metallicum	0	---	---	

Different letters indicate statistically significant differences among variants at $P < 0.05$

*, **, *** - Statistically significant differences of the variants vs. control at $P < 0.05$; 0.01 and 0.001, respectively

After the analysis of seed germination, it was established that there was no marked difference between the treated variants and the control one (Table 2). The variant treated with Zincum metallicum showed total suppression of seed germination. In the variants treated with Selenium, Magneziun fluoratum and Causticum Hanenmanni, the number of abnormally sprouted and rotten seeds increased, and the difference with the control one was not given.

Table 2. Germination of Venka 1 wheat seeds treated with homeopathic preparations

Variants	Mean, number	Difference, number	Significance	Group
Control	80,5			a
Calcium sulfuricum	90	9,5	ns	a
Thallium sulfuricum	80	-0,5	ns	a
Sulfur	92,5	12	ns	a
Graphites	90	9,5	ns	a
Selenium	57,5	-23	ns	a
Ferrum metallicum	80,5	0	ns	a
Magneziun fluoratum	65,5	-15	ns	a
Arsenicum album	80,5	0	ns	a
Causticum Hanenmanni	61	-19,5	ns	a
Zincum metallicum	0	---	---	---

Different letters indicate statistically significant differences among variants at $P < 0.05$

*, **, *** - Statistically significant differences of the variants vs. control at $P < 0.05$; 0.01 and 0.001, respectively

After measuring the length of the coleoptile and performing the statistical analysis, it was established that the variants treated with Thallium sulfuricum and Sulfur had a markedly longer coleoptile (Table 3). There was also a significant difference in the length of the primary roots, in the different variants, but they were not measured and therefore the difference in them cannot be proven. The variant treated with Zincum metallicum should be repeated using different potencies to determine whether they will also have an inhibitive effect. I believe that the study should continue with the study of other homeopathic preparations to determine their effect on uniform germination and their aftereffect on plant growth.

Table 3. The length of the coleoptile of Venka 1 wheat seeds, treated with homeopathic preparations

Variants	Mean, cm	Difference, cm	Significance	Group
Control	6,04			bc
Calcium sulfuricum	5.37	-0.67	---	ab
Thallium sulfuricum	6.95	0.91	+	de
Sulfur	7.42	1.37	++	e
Graphites	5.48	-0.56	---	ab
Selenium	5.23	-0.81	---	a
Ferrum metallicum	5.56	-0.48	---	ab
Magnezium fluoratum	5.6	-0.44	---	ab
Arsenicum album	6.4	0.35	ns	cd
Causticum Hanenmanni	5.47	-0.57	---	ab
Zincum metallicum	0	---	---	---

Different letters indicate statistically significant differences among variants at $P < 0.05$

*, **, *** - Statistically significant differences of the variants vs. control at $P < 0.05$; 0.01 and 0.001, respectively

Conclusions

The tested homeopathic preparations have no proven effect on the germination energy and germination of seeds of wheat variety Venka 1. The variants treated with the homeopathic preparations Thallium sulfuricum and Sulfur have been proven to exceed the standard one in terms of coleoptile length. I believe that the work on the study should continue with the study of other homeopathic preparations to determine their impact on uniform germination and their aftereffect on plant growth.

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