PROTECTIVE ACTIVITY OF VINYL-TRIAZOLIC DERIVATIVES AGAINST SOME CAUSATIVE AGENTS OF WHEAT ROOT ROT

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The article presents data on the action of triazole vinyl derivatives on *Fusarium oxysporum* and *Drechslera sorokiniana* pure fungus crops – causative agents of root rot in common autumn wheat and the influence of the treatment of wheat caryopsis with these compounds on the reaction of the plants to pathogens. Efficient concentrations of compounds that inhibit the fungal growth and increase the plant resistance to the action of fungal culture filtrates have been identified.

Keywords: wheat, root rot, *Fusarium oxysporum, Drechslera sorokiniana*, triazole vinyl derivatives.

INTRODUCTION

Root rot in plants, including straw cereal crops, is one of the most widespread and severe diseases and has quite diverse manifestations. For example, in wheat, root rot is manifesting by rotting of caryopsis, primary and secondary roots, coleoptile, twinning node, stem base, wilting in the seedling phase, clogging of mycelium-conducting vessels and grain padding, spicing, goiter with rough palettes, stunted seeds or black embryo (Tunali *et al.*, 2008; Xu *et al.*, 2008; Lupascu *et al.*, 2015).

In the conditions of the Republic of Moldova, for common winter wheat, root rot is produced by a large set of ubiquitous fungi spread in the soil, with optional or mandatory pathogenesis, which are part of several genera: *Fusarium, Helminthosporium (Bipolaris / Drechslera), Pythium, Rhizoctonia, Alternaria, Nigrospora*. It should be noted that environmental conditions greatly influence both the degree of attack of root rot and the composition of fungal species that cause the disease (Lupascu *et al.*, 2015).

Absolute resistance or immunity to root rot pathogens does not exist. This is explained by the high genetic polymorphism and wide polyphagia, the well-developed fermentative apparatus, the high adaptability to the unfavorable environmental conditions of the causative agents. For this reason, in the integrated systems of protection of root rot plants, along with the genotype factor, special

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attention is paid to the chemical factor – fungicides (Bolton et al., 2010). Prospects for the implementation of substances with antifungal activity in the management of plant diseases, including root rot are often limited by a number of factors - the lack of reproducibility of laboratory data in greenhouse or field conditions, the rather high cost price of preparations, the phenomenon of resistance of pathogens to fungicides, ecological imbalances that often lead to inefficiency of preparations. Although there is a wide range of fungicides, the number of newly identified and synthesized preparations is decreasing due to increased resistance of phytopathogens to chemicals or their negative impact on the environment (Shcherbakova et al., 2020) and plants (Nabeeva et al., 2015). For example, some of the known fungicides ("Bisol", "Biodues", "Cuprobisan") used in wheat strongly affect the redox system of plants, especially the activity of catalase and peroxidase, destroy some active forms of oxygen, which leads to accumulation of malonic dialdehyde (Nabeeva et al., 2015). Precisely due to the peculiarities of interaction of fungi, the environment and chemical preparations with the plant, the positive results of laboratory tests on the action of preparations on fungi do not always ensure the expected effect in field conditions.Thus, one of the basic impediments to combat the root rot is the lack of effective preparations, their dependence on environmental conditions, the high adaptability of disease-causing agents to newly created remedies, their pronounced toxicity to the plant and the environment. In connection with these, the identification of new compounds with antifungal activity broadens the spectrum of preparations used in the fight against root rot and retains the rapid adaptation of disease-causing agents to the chemical factor, which is of great practical interest in the plant protection system.

The aim of the present research was to establish the antifungal and protective activity of some triazole vinyl derivatives against some basic fungi involved in the production of root rot in common winter wheat.

MATERIAL AND METHODS

As material for research served: 1) the perspective line of common winter wheat L M / M3; 2) pure crops of the fungi *Fusarium oxysporum (F.o.)* and *Drechslera sorokiniana (D.s.)*, widespread in the Republic of Moldova for common winter wheat; 3) *F. oxysporum* and *D. sorokiniana* culture filtrates; 4) vinyl-triazole derivatives - MF-MZ 16-10, MF-EPS-853, MF-EPS-866, MF-EPS-165 in the concentrations: 0.00125, 0.0025, 0.005 and 0.01%.

It should be noted that *D. sorokiniana* grows much slower than *F. oxysporum*, which is why measurements of colony diameter in this fungus have been extended over a longer period of time.

The fungal strains *F. oxysporum*, *D. sorokiniana* were isolated aseptically on Potato Dextrose Agar (PDA) medium (Experimental mycology methods, 1982) from the base of common autumn wheat stems with signs of root rot. The identification of pathogens was performed based on their macro- and microscopic characteristics according to the mycological determinant Barnett, Hunter (1998).

The vinyl-triazole derivatives MF-MZ-16-10, MF-EPS-165, MF-EPS-853, MF-EPS-866 were obtained by condensing triazolyl ketones with aromatic aldehydes using the Knovenagel reaction (Jones, 2004).

MF-MZ-16-10 (Z) -4,4-dimethyl-1- (4-nitrophenyl) -2- (1H-1,2,4-triazol-1-yl) pent-1-en-3- one is a product of the interaction of 4-nitrobenzaldehyde with 3,3-dimethyl-1- (1H-1,2,4-triazol-1-yl) butane-2-one and has in its structure a tret-butyl moiety coupled with α, β - conjugate system formed by 4-nitrophenyl and 1H-1,2,4-triazol-1-yl radicals (Macaev, Zveaghintseva, Stangaci *et al*., 2017).

MF-EPS-165 (Z) -1- (2,4-dichlorophenyl)-5-methyl-2- (1H-1,2,4-triazol-1-yl) hex-1-en-3-one, obtained by the reaction of 2,4-dichlorobenzaldehyde and 3,3-dimethyl-1- (1H-1,2,4-triazol-1-yl) butan-2-one, shows an analogue of the substance nitrophenyl and the radicals 1H- 1,2,4-triazol-1-yl (Macaev, Stangaci, Pogrebnoi *et al*., 2020).

MF-EPS-853 (Z) -1- (2,4-dichlorophenyl) -4,4-dimethyl-2- (1H-1,2,4-triazol-1-yl) pent-1-en-3- one, obtained by the reaction of 2,4-dichlorobenzaldehyde with 3,3-dimethyl-1- (1H-1,2,4-triazol-1-yl) butan-2-one, is an analogue of the substance MF-MZ-16-10, wherein the 4-nitrophenyl moiety is substituted with the 2,4-dichlorophenyl radical (Macaev, Stangaci, Zveaghintseva *et al*., 2020).

MF-EPS-866 (Z) -1- (2,4-dichlorophenyl) -4,4-dimethyl-2- (1H-1,2,4-triazol-1-yl) pent-1-en-3- ol is an analogue of the substance MF-EPS-853, in which the ketogroup is substituted by the hydroxyl group (Lazari, Gomozha, Lazari, 1998).

It should be noted that initially the compound MF-MZ-16-10 was dissolved in 1% solution of Dimethylsulfoxide (DMSO), and MF-EPS-165, MF-EPS-853, MF-EPS-866 - in solution of 1% C_2H_5OH.

The establishing of the antifungal activity of triazole vinyl derivatives. Vinyl-triazole derivatives were supplemented to Potato Dextrosis Agar (PDA) in 0.01, 0.005, 0.0025, 0.00125%, which was subsequently asepticized by autoclaving at a pressure of 0.5 atm for 30 min. The aseptic medium was poured hot into Petri dishes, 10 ml each. After solidification of the medium, the fungi were seeded - one PDA disk with the fungus mycelium, 4 mm in diameter in the center of the Petri dish. The boxes with the seeded fungi were kept in the thermostat at a temperature of 24°C. The registration of the diameter of the colonies (2 perpendicular diameters, the average of which served as a biometric index) was made from day 3 for *F. oxysporum* and 6 – *D. sorokiniana*, due to the different growth rate of the fungi. The experiments were performed in 4 repetitions.

Establishing the protective activity of vinyl-triazole derivatives. The treatment of wheat grains with triazole vinyl derivatives was performed by soaking them for 3 hours in aqueous solutions of the compounds in concentrations of 0.01, 0.005, 0.0025%. After treatment, the grains were dried in the open air at room temperature for 24 hours, then kept for 18 hours in *F. oxysporum* and *D. sorokiniana* culture filtrates, after which they were 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 performed in 3 repetitions, 30 grains each. The following parameters were assessed: grain germination (%), root length (mm), stem length (mm), seedling length (cm), vigor index (germination,% x seedling length, cm), dry mass per seedling, mg.

The data were statistically processed in the software package STATISTICA 7.

RESULTS AND DISCUSSION

Antifungal activity of triazole vinyl derivatives. In the case of testing the action of vinyl-triazole derivatives on the fungus *F. oxysporum*, inhibitions of colony growth were found in most of the cases (Tab. 1, Fig. 1). The most significant inhibitory actions were recorded in the concentrations of 0.01 and 0.005%. Thus, on day 6 of the fungal growth, the average diameter of the colonies varied within the limits of 38.6 ... 52.1% and 38.7 ... 67.9% in relation to the control, respectively, the concentrations of 0.01 and 0.005%.

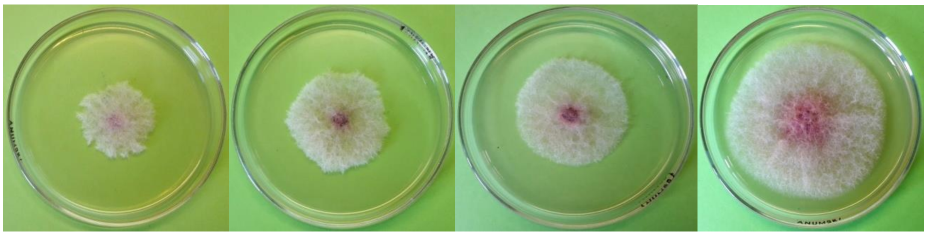
In the case of concentrations 0.0025% and 0.00125%, the analyzed index registered values of 55.8 ... 81.8% and 67.8 ... 104.4% in relation to the control, respectively. Based on the maximum concentrations (0.01, 0.005%) we can conclude that the compound MF-EPS-866 shows the most pronounced antifungal activity for *F. oxysporum*.

Table 1

The action of vinyl-triazole derivatives on the growth of *F. oxysporum* fungus

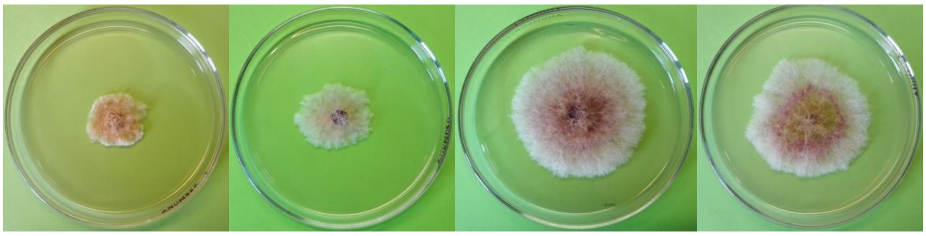
Nr. var.	Variants	Concen-trations, %	Diameter of the colony, mm				
			Day 3	Day 4	Day 5	Day 6	In comparison to the control in the day 6, %
1	Control (PDA)	-	26.3±3.5	37.9±4.7	48.6±4.5	63.3±5.5	-
2	MF-MZ-16-10	0.01	9.5±1.0*	15.2±1.6*	24.3±2.2*	31.9±3.9*	50.4
3		0.005	15.0±0.8*	23.4±1.1*	33.6±2.1*	43.0±2.8*	67.9
4		0.0025	18.4±1.0*	28.0±1.3*	39.0±1.6*	49.3±1.2*	77.9
5		0.00125	23.4±1.2*	35.9±1.9	50.2±2.4	66.1±2.9	104.4
6	MF- EPS-165	0.01	14.1±1.2*	17.7±0.6*	23.6±0.6*	31.7±1.2*	50.1
7		0.005	13.5±0.7*	19.3±1.9*	27.3±0.4*	33.5±1.6*	52.9
8		0.0025	21.0±1.2*	31.3±0.9*	41.2±1.6*	51.8±1.4*	81.8
9		0.00125	20.7±1.2*	28.5±2.3*	38.2±2.4*	50.1±2.8*	79.2
10	MF- EPS-853	0.01	10.8±1.6*	18.5±0.7*	24.9±1.4*	33.0±1.7*	52.1
11		0.005	8.9±0.7*	11.9±0.8*	18.1±1.7*	24.5±2.4*	38.7
12		0.0025	11.0±0.8*	18.3±1.3*	26.9±2.2*	35.3±2.5*	55.8
13		0.00125	16.2±1.0*	24.2±1.6*	33.4±2.2*	42.9±2.6*	67.8
14	MF- EPS-866	0.01	11.6±0.4*	16.0±1.2*	20.7±0.7*	24.4±1.1*	38.6
15		0.005	15.3±1.4*	21.7±0.9*	25.5±1.4*	29.7±1.5*	46.9
16		0.0025	21.2±0.9	27.1±1.2*	34.9±1.1*	42.8±1.6*	67.6
17		0.00125	21.7±0.8	30.6±1.0*	40.7±1.3	48.4±1.2*	76.5

*– difference with the control with statistical support p ≤0.05.



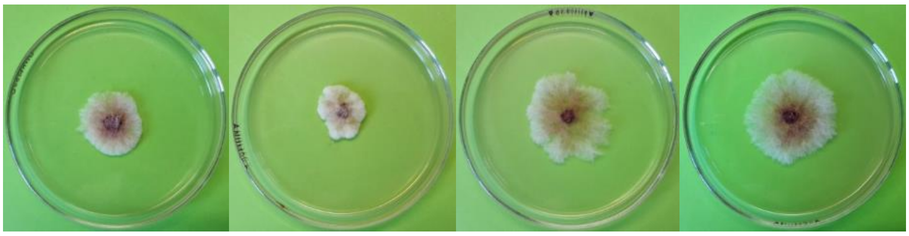
0.01% 0.005% 0.0025% 0.00125%

MF-MZ-16-10



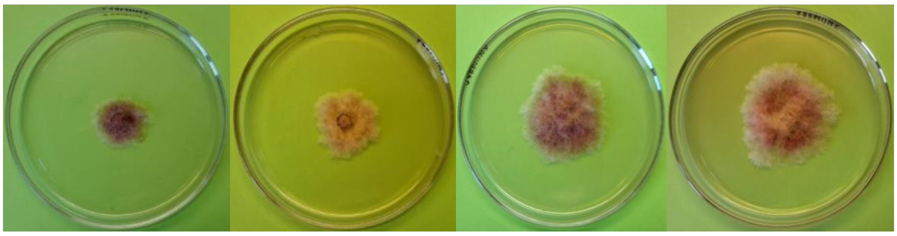
0.01% 0.005% 0.0025% 0.00125%

MF-EPS-165



0.01% 0.005% 0.0025% 0.00125%

MF-EPS-853



0.01% 0.005% 0.0025% 0.00125%

MF-EPS-866

Control

Fig. 1. Aspect of *F.oxysporum* colonies on PDA nutrient medium supplemented with vinyl-triazole derivatives.

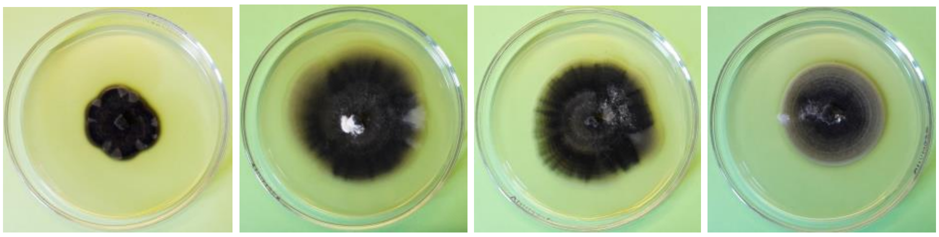
With regard to the fungus *D. sorokiniana*, a similar trend was found as in the case of *F. oxysporum* - higher inhibitory activity at high concentrations, but unlike *F. oxysporum*, the efficacy of the compounds was more diminished or even was produced the stimulation of the fungal growth: in the concentrations of 0.01 and 0.005% the diameter of the colonies in relation to the control varied in the limits of 78.2 ... 88.0% and 85.5 ... 143.0%, respectively (Tab. 2, Fig. 2).

Table 2

The action of vinyl-triazole derivatives on the growth of *D. sorokiniana* fungus

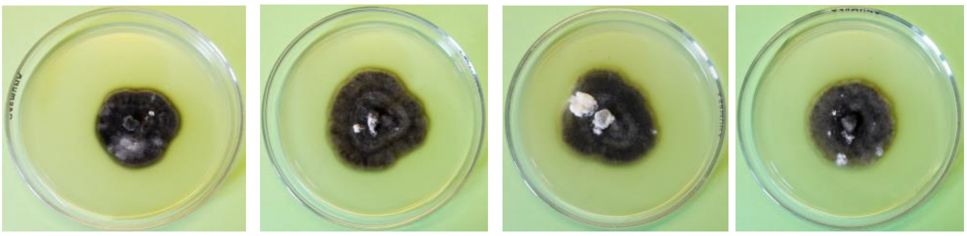
Nr. var.	Variant	Concen-trations, %	Diameter of the colony, mm				In comparison to the control in the day 16, %
			Day 6	Day 9	Day 12	Day 16	
1	Control (PDA)	-	24.7±1.5	31.0±1.5	35.1±1.0	44.1±1.8	-
2	MF-MZ-16-10	0.01	15.0±0.9*	25.0±1.2*	33.0±1.3	38.8±2.1	88.0
3		0.005	26.2±0.2	36.7±0.4	49.7±1.4	63.2±1.4	143.0
4		0.0025	29.2±1.2	38.5±3.5	40.0±2.6	51.2±2.6	116.1
5		0.00125	26.5±1.0	36.3±1.9	40.7±1.2	52.0±1.3	117.9
6	MF- EPS-165	0.01	10.2±0.7*	16.3±1.1*	22.2±1.7*	34.5±2.8*	78.2
7		0.005	15.5±0.6*	21.5±2.3*	32.7±1.3	42.5±2.0	96.4
8		0.0025	17.8±1.6*	24.3±1.6	30.8±1.6	41.0±3.2	93.0
9		0.00125	17.5±0.5*	24.8±1.9	29.3±2.4	35.3±1.6*	80.1
10	MF- EPS-853	0.01	19.3±0.6*	24.7±0.9	30.0±1.5*	36.5±1.5*	82.8
11		0.005	20.5±1.3	28.2±1.2	35.2±0.4	43.3±1.8	98.2
12		0.0025	22.5±1.8	26.5±1.6	33.0±0.4	40.8±1.3	92.5
13		0.00125	24.3±0.9	30.0±0.8	36.2±0,3	44.8±0.9	101.6
14	MF- EPS-866	0.01	15.2±1.1*	22.3±1.2*	30.0±0.6*	36.8±1.1*	83.5
15		0.005	16.0±2.0*	21.0±1.3*	28.8±2.2*	37.7±2.7	85.5
16		0.0025	19.5±1.3*	26.2±2.1	32.3±1.9	41.5±1.2	94.1
17		0.00125	18.2±0.6*	24.8±0.2	31.0±0.3	39.3±0.7	89.1

*– difference with the control with statistical support $p \leq 0.05$.



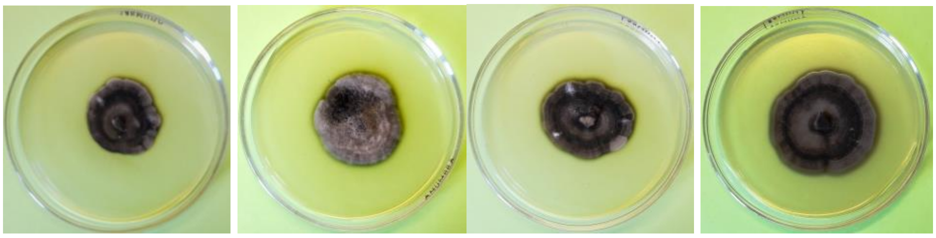
0.01% 0.005% 0.0025% 0.00125%

MF-MZ-16-10



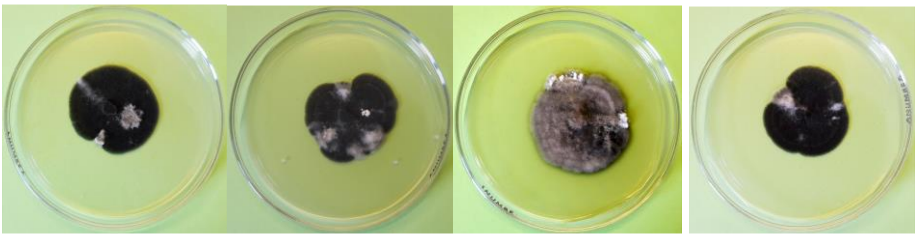
0.01% 0.005% 0.0025% 0.00125%

MF-EPS-165



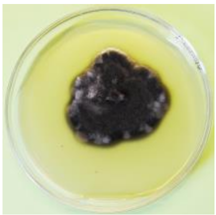
0.01% 0.005% 0.0025% 0.00125%

MF-EPS-853



0.01% 0.005% 0.0025% 0.00125%

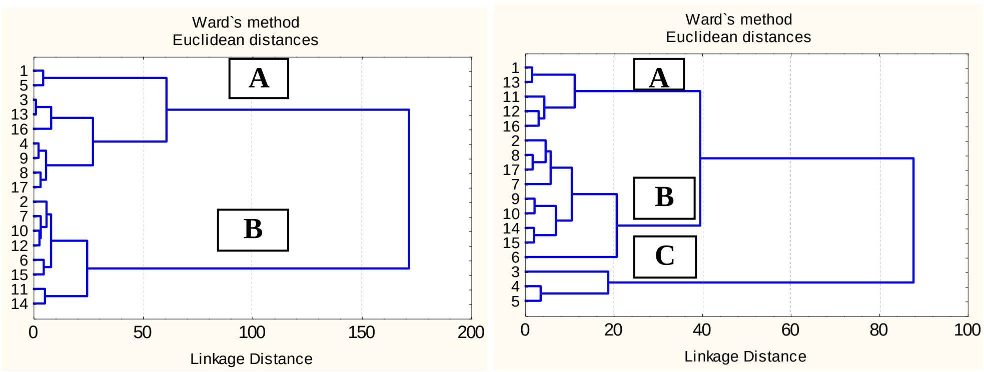
MF-EPS-866



Control

Fig. 2. Aspect of *D. sorokiniana* colonies on nutrient medium PDA supplemented with vinyl-triazole derivatives.

In order to investigate the similarity of antifungal activity of the compounds under study, cluster analysis was performed by the method of constructing dendrograms. Thus, it was found that in the case of *F. oxysporum* mushrooms, the preparations MF-EPS-165, MF-EPS-866 in concentrations 0.005, 0.01%, MF-MZ-16-10 – 0.01% and MF-EPS-853 – 0.0025%; 0.005; 0.01% who showed the highest antifungal activity formed cluster B. The other variants (compound / concentration) were practically at the control level and were located in cluster A (Fig. 3). Regarding the *D. sorokiniana*, 3 distinct clusters were formed. In cluster A were located compounds in the respective concentration that were at the level of the control – MF-EPS-853 (0.00125, 0.0025, 0.005%), MF-EPS-866 (0.0025%); in cluster B – variants with relatively weak inhibitory activity (78.2 ... 96.4%), MF-MZ-16-10 (0.01%), MF-EPS-165 in all concentrations; MF-EPS-853 (0.01%), MF-EPS-866 (0.00125, 0.005%, 0.01%), MF-EPS-866 (0.0025%); in cluster C – MF-MZ-16-10 - 0.00125, 0.0025, 0.005%) which had a stimulating effect: +17.9 ... + 43.0% in relation to the control.



F. oxysporum *D.sorokiniana*

Fig. 3. Dendrogram of distribution of triazole vinyl derivatives based on antifungal activity.

1 – Control (H_2O), 2 – MF-MZ-16-10 – 0.01%, 3 – MF-MZ-16-10 – 0.005%, 4 – MF-MZ-16-10 – 0.0025%, 5 – MF-MZ-16-10 – 0.0125%, 6 – MF- EPS-165 – 0.01%, 7 – MF- EPS-165 – 0.005%, 8 – MF- EPS-165 – 0.0025%, 9 – MF- EPS-165 – 0.00125%, 10 – MF- EPS-853 – 0.01%, 11 – MF- EPS-853 – 0.005%, 12 – MF-EPS-853 – 0.0025%, 13 – MF- EPS-853 – 0.00125%, 14 – MF- EPS-866 – 0.01%, 15 – MF- EPS-866 – 0.005%, 16 – MF- EPS-866 – 0.0025%, 17 – MF- EPS-866 – 0.00125%.

Protective capacity of triazole vinyl derivatives. *F. oxysporum* culture filtrate showed an inhibitory effect on all organs of wheat growth and development, except for the germination capacity of caryopsis.

Compound MF-MZ-16-10 stimulated the accumulation of dry mass in the plant in concentrations of 0.01% and 0.005% at the interaction of wheat with *F. oxysporum*, the character exceeding the variant "CF *F. oxysporum*" by 64.1 and 43.8%, respectively.

Compounds MF-EPS-165 and MF-EPS-853, in the range of investigated concentrations, contributed to the significant increase of almost all of the characters studied. In the case of such integral characters as the vigor index and the dry mass per plant, their values in relation to "CF *F. oxysporum*" under the influence of MF-EPS-165 increased by 70.3 ... 98.8% and 53.9 ... 65.2% , and under the influence of MF-EPS-853 - with 49.3 ... 87.6 and 41.6 ... 70.8%, respectively.

In the case of the preparation MF-EPS-866, stimulations of the character under study were found, especially in the concentration 0.0025%: compared to the variant "CF *F. oxysporum*", the values of the index of vigor and dry biomass per plant were with 83.7 and 55.1% higher, respectively (Tab. 3).

Table 3

The influence of vinyl-triazole derivatives on the growth and development indices of common wheat in interaction with *F. oxysporum*

Nr. var.	Variant	Germi-nation, %	Length of the root, mm	Length of the stem, mm	Seedling length, cm	Vigor index	Biomass per seedling, mg
1	Control – (H_2O)	100±0.0	120.5±2.9	67.5±2.0	18.8±0.4	1879.7±41.7	16.6±0.5
2	CF *F.oxysporum*	96.7±3.3	63.4±9.0 ^{v}	36.9±3.9 ^{v}	10.0±0.1 ^{v}	834.1±31.8 ^{v}	8.9±0.7 ^{v}
3	***MF- MZ 16-10***, 0.01% + CF *F.o.*	100±0.0	78.4±19.5	46.0±10.2	12.4±3.0	1540.5±30.8	14.6±0.3*
4	0.005% + CF *F.o.*	95.6±2.9	84.0±2.7	49.3±1.6	13.3±0.4	1275.5±73.0	12.8±0.4*
5	0.0025% + CF *F.o.*	87.8±2.2	73.5±1.4	48.7±0.7	12.2±0.1	1073.2±34.3	11.5±0.3
6	***MF-EPS-165,*** 0.01% + CF *F.o.*	96.7±3.3	90.9±4.7	55.7±1.9*	14.7±0.7	1420.3±110.3*	13.7±0.7*
7	0.005% + CF *F.o.*	100±0.0	104.5±2.8*	61.3±2.7*	16.6±0.5*	1658.3±54.4*	14.7±0.2*
8	0.0025% + CF *F.o.*	100±0.0	101.5±3.8*	60.4±2.5*	16.2±0.6*	1620.0±62.3*	14.0±0.5*
9	***MF-EPS-853***, 0.01% + CF *F.o.*	95.5±2.2	96.0±2.1*	55.4±2.8*	15.1±0.4	1444.6±9.5*	15.2±0.2*
10	0.005% + CF *F.o.*	97.8±2.2	96.6±4.6*	57.7±3.1*	15.4±0.8*	1564.4±62.3*	14.8±0.2*
11	0.0025% + FC *F.o.*	88.9±5.6	89.6±3.9	51.1±1.4*	14.0±0.5*	1245.2±45.6*	12.6±0.3*
12	***M-EPS-866***, 0.01% + CF *F.o.*	74.4±8.0	57.6±4.5	45.0±3.6	10.3±0.8	632.2±19.5	10.8±1.0
13	0.005% + CF *F.o.*	93.3±6.7	67.2±1.7	49.6±2.8	11.7±0.4	1202.4±46.7*	11.6±0.3
14	0.0025% + CF *F.o.*	100±0.0	91.6±2.3*	61.6±2.9*	15.3±0.5*	1531.9±50.3*	13.8±0.5*

*- difference with statistical support of "CF *F.oxysporum*" ($p \leq 0.05$);

^{v}- difference with statistical support of "Control (H_2O)" ($p \leq 0.05$).

Regarding the interaction of wheat x *D. sorokiniana*, the negative effect of the fungus on the accumulation of biomass in wheat plants was found. Under the influence of treating grains with CF, the dry biomass per seedling decreased by 17.9% compared to the control. For this character, there were increases of values in relation to "CF *D. sorokiniana*" of 19.5, 56.3 and 10.4% under the influence of compounds MF-MZ-16-10 (0.005), MF-EPS-165 (0.0025%) and MF-EPS-866 (0.0025%) (Tab. 4).

Table 4

The influence of vinyl-triazole derivatives on the growth and development indices of common wheat in interaction with *D. sorokiniana*

Nr. var.	Variant	Germination, %	Length of the root, mm	Length of the stem, mm	Seedling length, cm	Vigor index	Biomass per seedling, mg
1	Control – (H_2O)	95.6±4.4	74.1±6.3	38.5±4.4	11.3±0.6	1081.0±104.8	10.6±06
2	CF *D. sorokiniana*	90.0±3.3	66.9±7.1	34.2±3.0	10.1±0.6	905.9±27.3	8.7±0.1^{v}
3	***MF-MZ 16-10***, 0.01% + CF *D.s.*	88.9±6.8	62.4±11.9	33.7±4.4	9.6±0.9	846.9±68.6	8.9±0.4
4	0.005% + CF *D.s.*	86.7±5.1	65.4±5.1	35.7±3.4	10.1±0.5	874.4±52.7	10.4±0.1*
5	0.0025% + CF *D.s.*	87.8±6.2	69.5±7.5	35.2±1.0	10.5±0.5	919.4±81.6	9.0±0.2
6	***MF-EPS-165***, 0.01% + CF *D.s.*	74.4±12.8	64.2±9.4	34.6±5.4	9.9±0.9	715.4±61.3	7.4±0.7
7	0.005% + CF *D.s.*	68.9±10.6	61.2±11.6	32.5±6.8	9.4±1.1	663.0±152.5	4.9±0.3
8	0.0025% + CF *D.s.*	41.1±4.9*	64.2±7.4	36.1±6.4	10.0±0.8	409.4±48.3*	13.6±1.8*
9	***MF-EPS-853***, 0.01% + CF *D.s.*	84.4±1.1	60.8±4.9	31.4±1.7	9.2±0.4	778.1±29.0	8.5±0.3
10	0.005% + CF *D.s*	92.2±4.9	60.3±8.0	33.8±4.2	9.4±0.7	871.2±94.5	8.5±0.5
11	0.0025% + CF D.s.	72.2±10.9	67.0±6.9	35.6±4.6	10.3±0.7	732.6±89.8	8.5±0.7
12	***MF-EPS-866***, 0.01% + CF *D.s.*	85.6±7.3	46.2±3.4*	25.1±1.3*	7.4±0.5*	623.6±28.1*	7.0±0.7
13	0.005% + CF *D.s*	68.9±2.9*	55.1±3.6	32.4±1.6	8.8±0.3	602.4±24.0*	9.1±0.3
14	0.0025% + CF *D.s*	97.8±1.1	62.6±3.1	42.4±1.4*	10.5±0.3	1027.0±33.8*	9.6±0.2*

*- difference with statistical support of “CF *D. sorokiniana*” ($p \leq 0.05$);
^{v}- difference with statistical support of “Control (H_2O)” ($p \leq 0.05$).

Thus, the tested triazole vinyl derivatives showed different effects on the growth of some fungi – causative agents of root rot in wheat. The protective effect of the compounds depended a lot on the character of growth and development of the plant and their concentration.

CONCLUSIONS

1. Laboratory tests have shown that solutions of triazole vinyl derivatives – MF-MZ 16-10, MF-EPS-165, MF-EPS-853, MF-EPS-866 in concentrations 0.00125, 0.0025, 0.005, 0.01% showed pronounced antifungal activity in the case of the fungus *F. oxysporum*, and somewhat weaker – for *D. sorokiniana*.
2. By cluster analysis were identified triazole vinyl derivatives with similar antifungal activity (*F. oxysporum, D. sorokiniana*), which provides opportunities for substitution of the compounds if necessary in plant protection measures and broadening the spectrum of antifungal preparations, thus avoiding the rapid adaptation of the fungi to the new compounds.

3. It was found that the triazole vinyl derivatives under study show differentiated protective action in the phytopathosystems common wheat x *F. oxysporum/D. sorokiniana* which depends a lot on the pathogen, the concentration of the compound and the peculiarities of the reaction of the organs of plant growth and development.

4. Based on the data obtained on the integral characteristics of the plants – the vigor index and the dry mass per plant, can be recommended as protectors of wheat fungus from *F. oxysporum* the vinyl triazole derivatives MF-MZ-16-10 (0.005, 0.01%), MF-EPS-165 (0.00125–0.01%), MF-EPS-853 (0.00125–0.01%), MF-EPS-866 (0.0025%), and in the case of the fungus *D. sorokiniana* - MF-MZ-16-10 (0.005%), MF-EPS-165 (0.0025%) and MF-EPS-866 (0.0025%).

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