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Testing best combination fertilizer – phytosanitary treatment, in order to formulate appropriate management of *Pyrus comunis* nurseries

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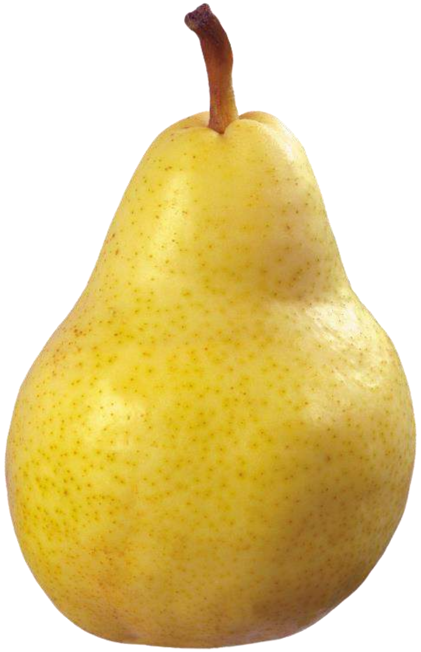

INTRODUCTION

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INTRODUCTION

Pear is well known as one of the most important tree fruit in the world, grown in all the continents of the world. It is very sensitive to cultural conditions, mainly in nurseries.

One of the most important inputs in pear tree development and protection against pathogens is fertilization.

The fertilization also affects the accumulation, mineralization and humification of organic matter added to the soil and determines pear tree production potential

It is well-known that in pear shoots, like in other nursery fruit tree species, heath status is strongly influenced by shoots vigor (height, diameter, coefficient of slenderness).

In pear tree nurseries located in experimental area the most important pathogens are *Podosphaera leucotricha*, and *Venturia inaequalis* (Cke.) Wint.

While in order to ensure optimal growing conditions for rootstocks in conventional nurseries, different mineral fertilizers are used (Zygmunt, 2012), researches on the use of unconventional fertilizers are becoming more and more appalling.

On the other side, the potentiality of an unconventional fertilizer, fly-ash, is becoming more popular day by day for its use in agriculture, due to the fact that it contains almost all the essential plant nutrients, except organic carbon and nitrogen with for great benefits for improving soil's proprieties

Fertilization with increasing doses of macro elements (NPK) causes an increase in total antioxidant capability of the soil, as well as in fresh leaf mass.

Used as well as unconventional fertilizer for agricultural and horticultural crops, the magnetic fertilizer is made of magnetic elements with wide frequency spectrum, paramagnetic elements, gemstones, special oxides and fixing elements

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INTRODUCTION

The aim of our study was to emphasize the influence of different conventional and unconventional fertilization solutions applied in pear tree nurseries, upon shoots development and resistance against common pathogens reported in studied area, *Podosphaera leucotricha* (which produces **pear powdery mildew**), and *Venturia inaequalis* (Cke.) Wint which produces **pear scab**.

Podosphaera leucotricha
Pear powdery mildew

Venturia inaequalis
Pear scab

MATERIAL AND METHODS

MATERIAL AND METHODS

The research was conducted in an experimental field, placed in Vâlcele, Cluj – Napoca.

Pear shoots were planted in March 2014, on a surface of **764 m^2**, in a randomized complete block design (RCBD) with **3 replications** and **9 variants** with a plot size of **20 m^2** for variant. Protection measures against diseases and pests were carried out according to the experimental protocol, for all fertilized plots.

Three fertilization treatments were applied to the plots:

- NPK fertilizer 15:15:15,170 kg ha^{-1}
- Fly ash, 2t ha^{-1}
- Magnetic fertilizer,10 ha^{-1}

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Both conventional and unconventional fertilizers were applied twice: the first time at planting (**mid-March**) and the second time in **mid-July**. Agro technical measures were applied in order to remove soils crust before and after each application of fertilizer, and to facilitate its incorporation in soil.

Treatments against **pear powdery mildew** and **pear scab** were performed with **Dithane M-45- WG,** from Syngenta.

Ten saplings randomly chosen, from each fertilized variant, were analyzed. For each pear seedling, growth was evaluated by measuring the increase of the trunk diameter (at a height of 5 cm above ground). In the autumn (mid-October), after measuring, the obtained data was statistically interpreted.

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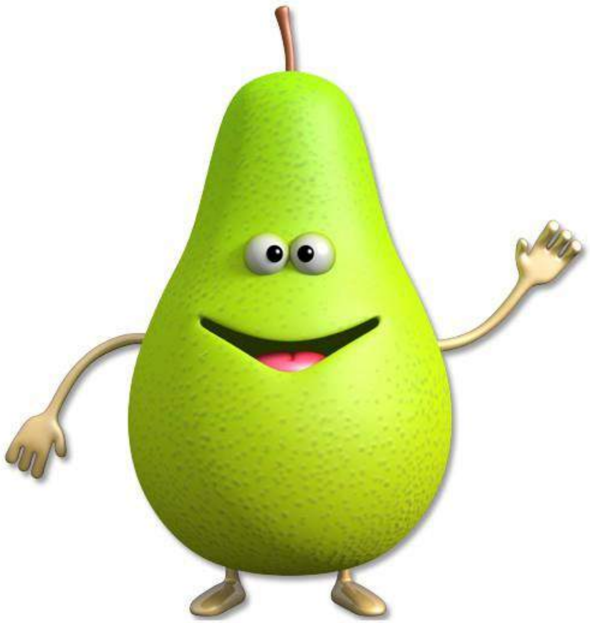
The STATSTICA v. 7.0 programme was used in order to process raw data.

Basic statistics was calculated for control, each fertilization variant, and both monitored pathogens (pear powdery mildew, and pear scab) attack degrees.

Means and standard error of means are presented as Box-Plot diagrams.

Significance of differences was calculated between experimental variants using ANOVA test.



RESULTS AND DISCUSSIONS

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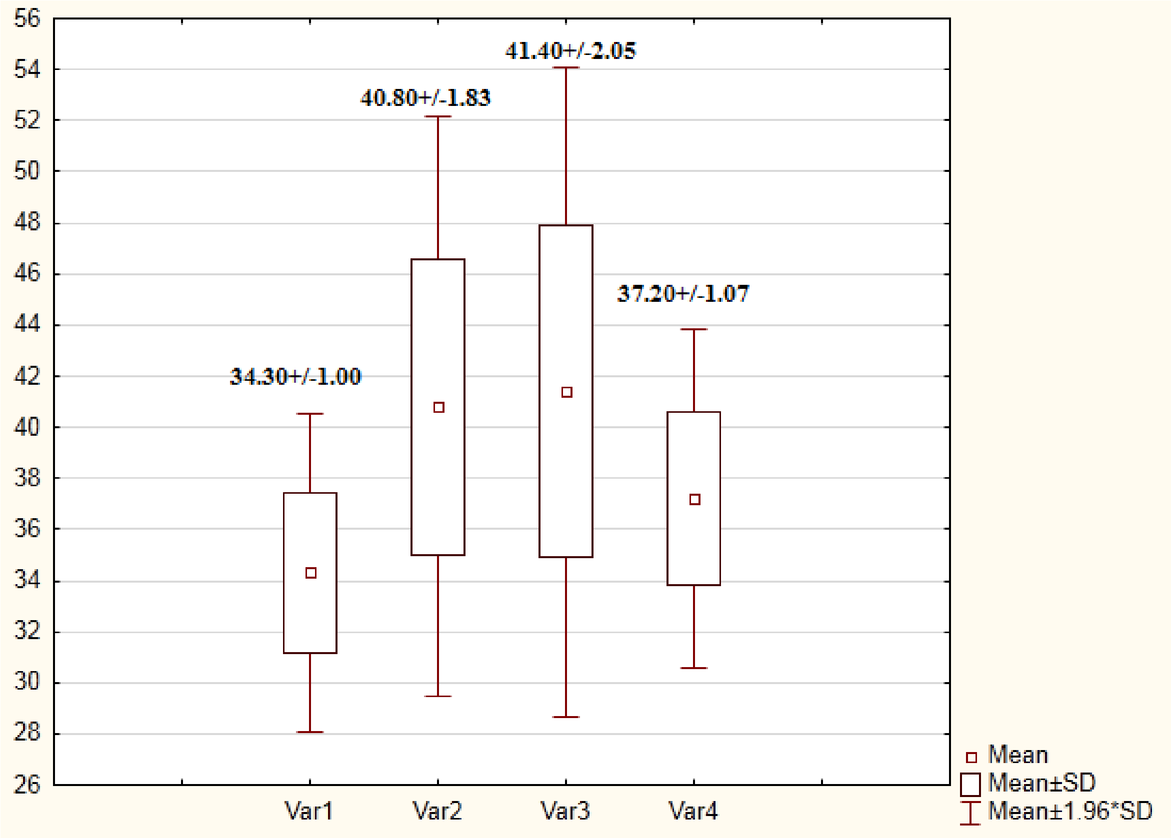

Note 1: Var 1 – Control – not fertilized, not treated; Var 2 – variant fertilized with $N_{15}P_{15}K_{15}$; Var 3 – variant fertilized with magnetic fertilizer; Var 4 – variant fertilized with fly ash.

Fig. 1. The Box-Plot diagram of shoots' heights averages correspondent to each fertilization variant during experimental period, March – October 2014

The Box – Plot diagram emphasizes that in pear shoots' heights averages correspondent to each fertilization variant during experimental period (March – October 2014).

The biggest height growing average was recorded in variant that received magnetic fertilizer, 41.40 ± 2.05 cm

It is followed by variant conventionally fertilized that received $N_{15}P_{15}K_{15}$ mineral fertilization with an average of 40.80 ± 1.83 cm, and variant that received fly ash fertilizer, with an average of 37.20 ± 1.07 cm

The smallest average is reported in control, not fertilized, where the average pear shoots' height is of 34.30 ± 1.00 cm

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RESULTS AND DISCUSSIONS

Issue	Control	Var 1	Var 2	Var 3
n	10	10	10	**10**
Standard deviation	3.16	5.79	6.48	**3.39**
Variance	10.01	33.51	42.04	**11.51**
Skewness	0.29	0.92	1.03	**0.21**
Kurtosis	1.34	0.31	0.63	**1.13**
Differences		[+1]-6.50**	[+2]-7.10**	**[+3]-2.90[ns]**
			[+4]-0.60[ns]	**[+5]-3.60[ns]**
				[+6]+4.20[ns]
DF	**18**			

Table 1: Basic statistics and significance of differences between experimental variants, concerning shoots height, reported function of fertilization variant

Note 1: Control – not fertilized, not treated; Var 1 – variant fertilized with $N_{15}P_{15}K_{15}$; Var 2 – variant fertilized with magnetic fertilizer; Var 3 – variant fertilized with fly ash;

Note 2: [+1] – differences between average shoots height of Control and Var 1; [+2] – differences between average shoots height of Control and Var 2; [+3] – differences between average shoots height of Control and Var 3; [+4] – differences between average shoots height of Var 1 and Var 2; [+5] – differences between Var 2 and Var 3.

Note 3: ns – $p > 0.05$, ** - $p < 0.01$.

Basic statistics reveals the normal distribution of pear shoots' heights. Between majorities of variants **no significant differences** ($p > 0.05$) are reported. Nevertheless, two exceptions are recorded, both between Control and other two experimental variants.

One, between Control and Variant 1 (fertilized with $N_{15}P_{15}K_{15}$) and second between Control and Variant 2 (fertilized with magnetic fertilizer). The differences between shoots average heights are of 6.50 cm and 7.10 cm statistically assured at significance threshold of 1%.

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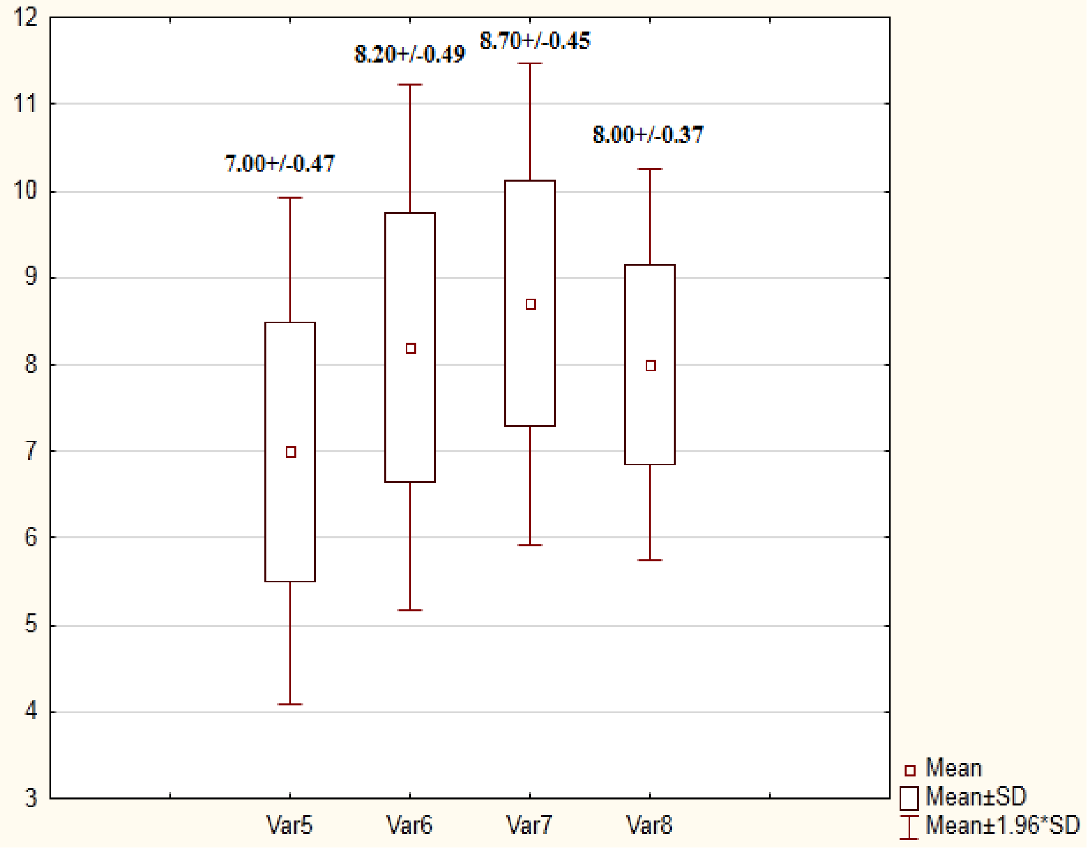
RESULTS AND DISCUSSIONS



Note 1: Var 5 – Control – not fertilized, not treated; Var 6 – variant fertilized with $N_{15}P_{15}K_{15}$; Var 7 – variant fertilized with magnetic fertilizer; Var 8 – variant fertilized with fly ash.

Fig. 2. The Box-Plot diagram of shoots' diameters averages correspondent to each fertilization variant during experimental period, March – October 2014

The Box – Plot diagram emphasizes the biggest diameter average in variant that received magnetic fertilizer, 8.70 ± 0.45 cm

It is followed by variant conventionally fertilized that received $N_{15}P_{15}K_{15}$ mineral fertilization with an average of 8.20 ± 0.49 cm, and variant that received fly ash fertilizer, with an average of 8.00 ± 0.37 cm

The smallest average is reported in control, not fertilized, where the average pear shoots' height is of 7.00 ± 0.47 cm

RESULTS AND DISCUSSIONS

Issue	Control	Var 1	Var 2	Var 3
n	10	10	10	10
Standard deviation	1.49	1.15	1.42	1.55
Variance	2.22	1.33	2.01	2.40
Skewness	0.02	0.05	0.22	0.86
Kurtosis	1.33	0.08	0.40	0.63
Differences		[+1]-1.20[ns]	[+2]-1.70*	[+3]-1.00[ns]
			[+4]-0.50[ns]	[+5]+0.20[ns]
				[+6]+1.70[ns]
DF	18			

Table 2: Basic statistics and significance of differences between experimental variants concerning shoots diameter, reported function of fertilization variant

Note 1: Control – not fertilized, not treated; Var 1 – variant fertilized with $N_{15}P_{15}K_{15}$; Var 2 – variant fertilized with magnetic fertilizer; Var 3 – variant fertilized with fly ash;

Note 2: [+1] – differences between average shoots height of Control and Var 1; [+2] – differences between average shoots height of Control and Var 2; [+3] – differences between average shoots height of Control and Var 3; [+4] – differences between average shoots height of Var 1 and Var 2; [+5] – differences between Var 2 and Var 3.

Note 3: ns – $p > 0.05$, * - $p < 0.05$.

Basic statistics reveals the normal distribution of pear shoots' diameters.

Except the average diameters reported in control and variant fertilized with magnetic fertilizer where the difference of 1.70 cm in advantage of shoots fertilized with magnetic fertilizer is significant at significance threshold of 5%, in rest of variants, no significant differences ($p > 0.05$) are reported

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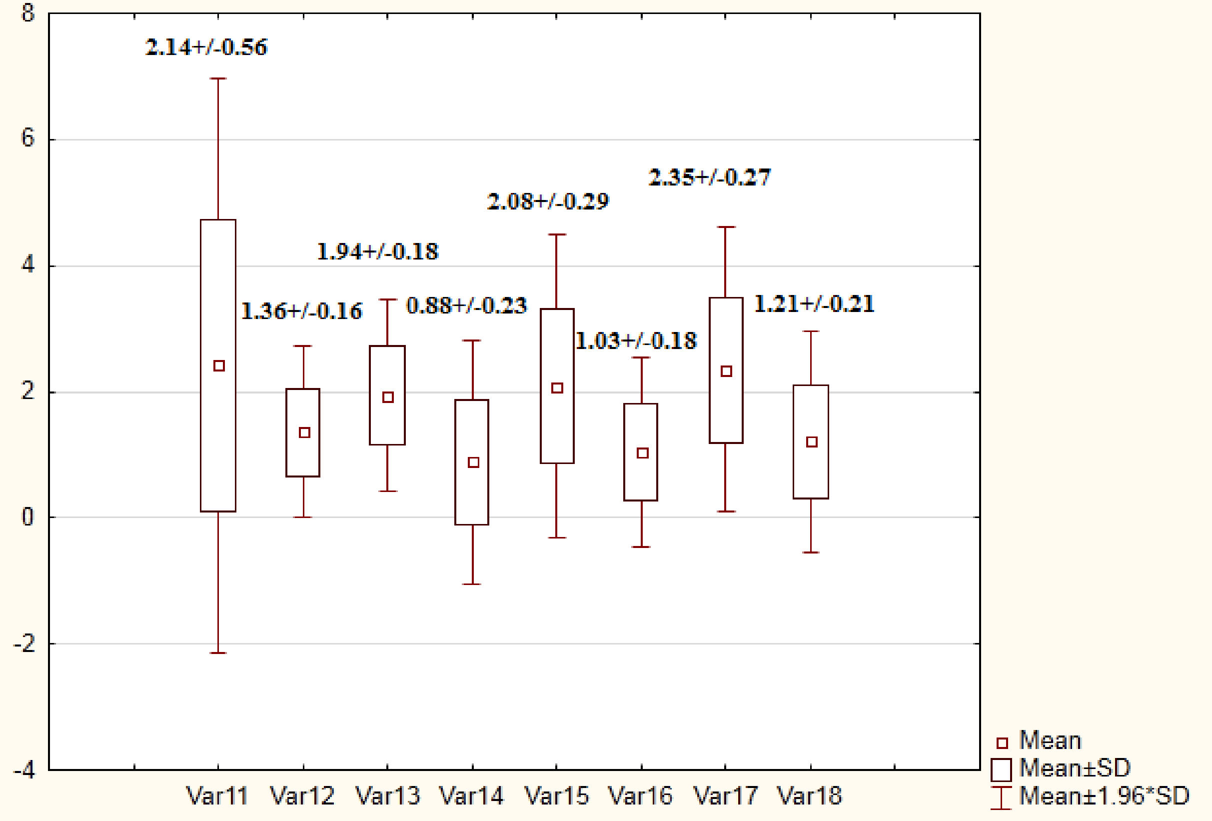

In experimental variant not treated and not fertilized (Control 2), was reported the biggest mean (2.08±0.29%), while in variant mineral fertilized with $N_{15}P_{15}K_{15}$ the smallest average attack degree, of 1.03±0.18% is recorded

Note 1: Var 11 – Control 1 – attack degree of pear powdery mildew in not fertilized, not treated pear shoots; Var 12 – Control 2 – attack degree of pear scab in not fertilized, not treated pear shoots; Var 13 – attack degree of pear powdery mildew in variant fertilized with $N_{15}P_{15}K_{15}$; Var 14 – attack degree of pear powdery mildew in variant fertilized with magnetic fertilizer; Var 15 – attack degree of pear powdery mildew in variant fertilized with fly ash; Var 16 – attack degree of pear scab in variant fertilized with $N_{15}P_{15}K_{15}$; Var 17 – attack degree of pear scab in variant fertilized with magnetic fertilizer; Var 18 – attack degree of pear scab in variant fertilized with fly ash.

Fig. 3. The Box-Plot diagram of pear powdery mildew and pear scab average attack degrees correspondent to each fertilization variant during experimental period, March – October 2014

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RESULTS AND DISCUSSIONS

Issue	Control	Var 1	Var 2	Var 3
n	17	17	17	**17**
Standard deviation	2.32	0.77	0.63	**1.23**
Variance	5.38	0.60	0.40	**1.51**
Skewness	1.17	0.44	2.30	**1.60**
Kurtosis	0.17	1.15	5.36	**4.26**
Differences		$^{+1}+0.78^{ns}$	$^{+2}+0.20^{ns}$	**$^{+3}-+1.26^{**}$**
			$^{+4}-0.58^{*}$	**$^{+5}-0.48^{ns}$**
				$^{+6}-1.06^{**}$
DF	**32**			

Table 3: Basic statistics and significance of differences between experimental variants concerning pear powdery mildew attack degrees, reported function of fertilization variant

Note 1: Control – not fertilized, not treated; Var 1 – variant fertilized with $N_{15}P_{15}K_{15}$; Var 2 – variant fertilized with magnetic fertilizer; Var 3 – variant fertilized with fly ash;

Note 2: $^{+1}$ – differences between average shoots height of Control and Var 1; $^{+2}$ – differences between average shoots height of Control and Var 2; $^{+3}$ – differences between average shoots height of Control and Var 3; $^{+4}$ – differences between average shoots height of Var 1 and Var 2; $^{+5}$ – differences between Var 2 and Var 3.

Note 3: ns – $p > 0.05$, * - $p < 0.05$, ** - $p < 0.01$.

Concerning pear powdery mildew attack degree, the biggest mean was identified in Control 1 (2.14±0.56%), while the smallest in variant fertilized with ash-fly (0.88±0.23%).

The normal distributions of the average attack degrees evolution is revealed by the basic statistics.

Significant differences ($p < 0.01$) of 1.26%, and 1.06% are reported between the average attack degrees of pear powdery mildew in control and variant fertilized with ash-fly, and between the average attack degrees of pear powdery mildew in variant fertilized with magnetic fertilizer and variant fertilized with ash-fly

A distinct significant difference ($p<0.05$), of 0.58%, was recorded between the average attack degrees of pear powdery mildew in variant mineral fertilized with $N_{15}P_{15}K_{15}$ and variant fertilized with ash-fly

RESULTS AND DISCUSSIONS

Issue	Control	Var 1	Var 2	Var 3
n	17	17	17	**17**
Standard deviation	0.69	0.77	1.15	**0.89**
Variance	0.48	0.59	1.32	**0.80**
Skewness	0.54	0.95	1.72	**0.45**
Kurtosis	0.05	0.68	3.83	**1.11**
Differences		$^{+1}$+1.05**	$^{+2}$-0.27^{ns}	**$^{+3}$+0.87^{ns}**
			$^{+4}$-1.32***	**$^{+5}$-0.18^{ns}**
				$^{+6}$+1.14**
DF		**32**		

Table 4: Basic statistics and significance of differences between experimental variants concerning pear scab attack degrees, reported function of fertilization variant

Note 1: Control – not fertilized, not treated; Var 1 – variant fertilized with $N_{15}P_{15}K_{15}$; Var 2 – variant fertilized with magnetic fertilizer; Var 3 – variant fertilized with fly ash;

Note 2: $^{+1}$ – differences between average shoots height of Control and Var 1; $^{+2}$ – differences between average shoots height of Control and Var 2; $^{+3}$ – differences between average shoots height of Control and Var 3; $^{+4}$ – differences between average shoots height of Var 1 and Var 2; $^{+5}$ – differences between Var 2 and Var 3.

Note 3: ns – p > 0.05, ** - p < 0.01, *** - p < 0.001.

The basic statistics emphasizes the normal distributions of the pear scab average attack degrees.

Significant differences ($p < 0.01$) of 1.05%, and 1.14% are reported between the average attack degrees of pear scab in control and variant mineral fertilized with $N_{15}P_{15}K_{15}$, and between the average attack degrees of pear scab in variant fertilized with magnetic fertilizer and variant fertilized with ash-fly

A very significant difference ($p<0.001$), of 1.32%, was recorded between the average attack degrees of pear scab in variant mineral fertilized with $N_{15}P_{15}K_{15}$ and variant fertilized with magnetic fertilizer

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RESULTS AND DISCUSSIONS

Issue	R	R^2	Regression line	p
$AD_1 – H_C – D_C – CS_C$	+0.331^{ns}	0.110	Y = - 26.37-1.00X1+2.43X2+1.87X3	0.413
$AD_1 – H_{VAR1} – D_{VAR1} – CS_{VAR1}$	+0.464^{ns}	0.216	Y = - 2.69-0.58X1+0.92X2+1.46X3	0.661
$AD_1 – H_{VAR2} – D_{VAR2} – CS_{VAR2}$	+0.567^{ns}	0.322	Y = - 17.71-2.19X1+2.62X2+2.22X3	0.589
$AD_1 – H_{VAR3} – D_{VAR3} – CS_{VAR3}$	+0.602^{ns}	0.362	Y = - 11.31-0.03X1+0.99X2+0.57X3	0.486

Table 5: The multiple regression analysis applied to interactions between pear powdery mildew average attack degree (AD_1, %) and shoots average height (H), average diameter (D) and average coefficient of slenderness (CS), by monitored period, April – October 2014, in experimental area

Note 1: Control – not fertilized, not treated; Var 1 – variant fertilized with $N_{15}P_{15}K_{15}$; Var 2 – variant fertilized with magnetic fertilizer; Var 3 – variant fertilized with fly ash;
Note 2: X1 – shoots height (H), X2 – shoots diameter (D), X2 – shoots coefficient of slenderness (X3);
Note 3: ns – p > 0.05, * - p < 0.05.

The multiple regression analyze of the interactions between pear powdery mildew average attack degree and shoots average height, diameter, and coefficient of slenderness reveals weak to average interactions in studied parameters, but statistically not significant

The regression lines suggest that, in all variants, the diameters and coefficient of slenderness increases favourize the attack, while the height increase negatively influences the disease attack.

In variant fertilized with flying ash, biggest interaction is identified between pear shoots traits and pear powdery mildew attack degree.

RESULTS AND DISCUSSIONS

Issue	R	R^2	Regression line	p
$AD_1 - H_C - D_C - CS_C$	+0.265 ns	0.070	Y = -13.58-1.55X1+1.29X2+1.04X3	0.692
$AD_1 - H_{VAR1} - D_{VAR1} - CS_{VAR1}$	+0.795 *	0.632	Y = -3.90-0.64X1+0.81X2+1.75X3	0.034
$AD_1 - H_{VAR2} - D_{VAR2} - CS_{VAR2}$	+0.415 ns	0.172	Y = +8.89+2.11X1-2.31X2-2.14X3	0.601
$AD_1 - H_{VAR3} - D_{VAR3} - CS_{VAR3}$	+0.664 *	0.441	Y = +12.54+2.49X1-3.45X2-4.58X3	0.016

Table 6: The multiple regression analysis applied to interactions between pear scab average attack degree (AD_1, %) and shoots average height (H), average diameter (D) and average coefficient of slenderness (CS), by monitored period, April – October 2014, in experimental area

Note 1: Control – not fertilized, not treated; Var 1 – variant fertilized with $N_{15}P_{15}K_{15}$; Var 2 – variant fertilized with magnetic fertilizer; Var 3 – variant fertilized with fly ash;
Note 2: X1 – shoots height (H), X2 – shoots diameter (D), X2 – shoots coefficient of slenderness (X3);
Note 3: ns – p > 0.05, * - p < 0.05.

In control, and experimental variant fertilized with mineral fertilizer, the diameters and coefficient of slenderness increases, favourize the attack, while the height increase, negatively influences the disease attack, in terms of a weak correlation (R=0.265), statistically not significant (p>0.5).

In variant mineral fertilized with $N_{15}P_{15}K_{15}$, we report a strong multiple correlation (R =0.795). This is the biggest multiple correlation of experimental variants we tested, statistically assured at significance threshold of 5%

The regression lines show that in experimental variants fertilized with magnetic fertilizer and fly-ash, the diameters and coefficient of slenderness decrease have negative influence on scab attack while the height increase, positively influences the pear scab attack. In variant fertilized with magnetic fertilizer we report an average correlation (R=0.415), not assured at significance threshold of 5%

In variant fertilized with fly-ash, a strong multiple correlation (R =0.664) was recorded. It is statistically assured at significance threshold of 5%.

CONCLUSIONS

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CONCLUSIONS

Our study demonstrates the importance of fertilization is both pear shoots development and resistance against common pathogens identified in nurseries from experimental area located in Transylvanian Plane.

Concerning shoots development, we obtained best results when we practiced the fertilization solution, which involves the use of magnetic fertilizer. In this variant we report the biggest average height and diameter (41.40 cm, and 8.70 cm, respectively).

The weakest results were obtained, as expected, in not fertilized control (34.30 cm, and 7.00 cm, respectively), while, in other variants, intermediary results may be emphasized (40.80 cm average height and 8.20 cm average diameter in variant mineral fertilized with $N_{15}P_{15}K_{15}$, 37.20 cm height and 8.00 cm diameter, in variant fertilized with fly-ash).

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CONCLUSIONS

The pear powdery mildew attack degree recorded the biggest value in control (2.14%).

The best fertilization solution, in pear powdery mildew was the ash-fly fertilization. In this experimental variant we obtained the weakest attack of the pathogen, with an average attack degree of 0.88%.

Concerning pear scab attack, the best fertilization solution was delivered by mineral $N_{15}P_{15}K_{15}$ fertilization (average attack degree = 1.03%), while magnetic fertilization led to biggest average attack degree (2.35%), superior compared to control (2.08%).

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