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IMPACT OF PRECEDING CROP AND VARIETY ON GRAIN YIELD AND QUALITY PARAMETERS IN WINTER WHEAT CULTIVATED IN DÂMBOVIȚA COUNTY

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Abstract

The experimental research developed during 2017-2018 in Morteni Commune, Dâmbovița County using Exotic and Solehio wheat varieties was based on the investigation of the variability of (i) yield components (yield, number of spikes/m^2, hectolitre mass HLM, thousand kernel weight TKW) and of (ii) quality parameters (wet gluten, crude protein content) influenced by preceding crops and by wheat variety in correlation with different agrophysiological crop parameters (plant height, spike length). The experimental scheme was composed from 4 plots, as it follows: plots 1 and 3 with Exotic wheat variety and plots 2 and 4 with Solehio wheat variety. The crop rotation sequence for plots 1 and 2 was maize (2016-2017), sunflower (2015-2016), wheat (2014-2015) and for plots 3 and 4 was sunflower (2016-2017), maize (2015-2016), wheat (2014-2015). The results of the research indicated that yield, spike length, number of spikes/m^2, HLM and TKW parameters were higher after sunflower as preceding crop, meanwhile the plant height, gluten and protein contents were higher after maize as preceding crop for both wheat varieties.

Key words*: crop rotations, gluten, protein, wheat, yield components.*

INTRODUCTION

Experimental trials conducted on wheat culture demonstrated that balanced fertilization ensure high yields, nitrogen being considered as the most influential factor for good quality of grains, protein content and bread-making quality. Reviewing the literature data, it was found many papers dealing with importance of fertilization on yield components and quality parameters (Basso et al., 2010; Bunta et al., 2011; Hlisnikovsky et al., 2016; Panayotova et al., 2017; Starodub et al., 2017; Madjar et al., 2018). Some studies sustain use of liquid fertilizers to obtain high yields (Watson et al., 1992; Madjar et al., 2018). Accordingly, a research paper (Madjar et al., 2018) evidenced that splitting the nitrogen dose applied as liquid fertilizer on wheat, led to higher yields and influenced positively some yield components and quality parameters.

But to reduce the use of nitrogen and therefore to minimize its environmental effects, some practices are adopted, one of them being crop rotation. Beside yield increase, crop rotation is an important strategy to manage properly insects, weeds, to improve soil properties (Roth, 1996).

Wheat produce higher yields when is grown after unrelated species, the importance of rotation being recognized since ancient times.

The inclusion of oilseed crops in crop rotation has positive agronomic impact, this being evidenced in a study (Litke et al., 2017) which revealed in the case of wheat, the increase of yield and TKW parameter when preceding crop was oilseed rape.

Some authors (Lopez-Bellido Garrido et al., 2001) developed a field study to investigate the effects of crop rotation (wheat-sunflower, wheat-chickpea, wheat-faba bean, wheat-fallow and continuous wheat) and N fertilizer (rates 50, 100, 150 kg N·ha^{-1}) on wheat yield and it evidenced that chickpea rotation on yield was significantly smaller than of faba bean rotation and closer to sunflower rotation.

For wheat as main crop, other authors (Dogan et al., 2008) found that the most suitable crop rotation systems for Southern Marmara region, Turkey are sunflower-rapeseed-wheat, rapeseed-fodder pea + sunflower-wheat and rapeseed-common vetch + sunflower-wheat.

The investigation of influence of crop rotation (winter wheat-monocrop, winter wheat-maize, pea-winter wheat-maize, pea-winter wheat-maize-maize) and fertilization (N_0P_0, $N_{120}P_{80}$,

$N_{120}P_{80}$ + manure 10 t·ha^{-1}, applied for every crop) on biomass and yield evidenced the smallest values of subjected parameters in winter wheat monocrop case (Ardelean & Bandici, 2013).

Having in view above mentioned information, the paper presents the results obtained on the basis of an experimental research developed during 2017-2018 in Morteni Commune, Dambovita County.

The aim of the research was to investigate in the case of Exotic and Solehio wheat varieties, the variability of **(i)yield components** (yield, number of spikes/m^2, hectolitre mass HLM, thousand kernel weight TKW) and of **(ii)quality parameters** (wet gluten, crude protein content) influenced by preceding crops and by wheat variety in correlation with different agrophysiological crop parameters (plant height, spike length).

MATERIALS AND METHODS

Experimental site

Experimental research was carried out in Morteni Commune, Dâmbovița County (Figure 1).

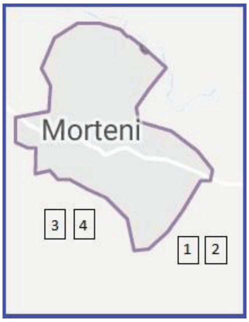

Figure 1. The position of experimental plots on Morteni Commune map

Wheat varieties

For the experiment were chosen Exotic and Solehio wheat varieties from KWS.

Fertilizers

In the experiment were used NPK 18: 46: 0, calcium ammonium nitrate (CAN) with 27% N and urea with 46% N.

Experimental design

The experimental scheme was composed from 4 plots, as it follows: plots 1 and 3 with Exotic wheat variety and plots 2 and 4 with Solehio wheat variety (Table 1). It was developed a bifactorial experiment where **a** factor was wheat variety (Exotic, Solehio) and **b** factor was preceding crop.

Table 1. Crop rotation sequence during 2014-2018

Year	Plot 1	Plot 2	Plot 3	Plot 4
2017-2018	Wheat (Exotic)	Wheat (Solehio)	Wheat (Exotic)	Wheat (Solehio)
2016-2017	Maize	Maize	Sunflower	Sunflower
2015-2016	Sunflower	Sunflower	Maize	Maize
2014-2015	Wheat	Wheat	Wheat	Wheat

Soil and plant analyses

A presentation of performed analyses, methods and apparatus are synthesized in Table 2.

Table 2. Analyses, methods and instrumentation

Analyses	Method	Apparatus
	Soil	
pH_{H2O} (1: 2.5)	potentiometry	Hanna pH-meter
Total soluble salts (1: 5), TSS	conductometry	HACH sensION 7
Potassium (mobile form), K_{AL}	flame emission spectrometry	Sherwood 410
Phosphorus (mobile form), P_{AL}	spectrophotometry	CECIL 2041 spectrophotometer
Humus content, H	Walkley-Black-Gogoașă	-
	Plant	
Wet gluten	manual method	-
Crude protein content (on the basis of total nitrogen content)	Kjeldahl method	HACH Digesdahl

P_{AL} - mobile form of phosphorus using for extraction ammonium acetate-lactate (AL)

K_{AL} - mobile form of potassium using for extraction ammonium acetate-lactate (AL)

Fertilization and applied treatments

For both wheat varieties was adopted the same technology and phytosanitary treatments (Table 3). The sowing was done in October, first decade and harvesting in June, the third decade.

Table 3. Fertilization and phytosanitary treatments scheme for Exotic and Solehio wheat varieties

Period of time	Fertilizer and phytosanitary treatments	Dose
September, IIIrd decade	NPK 18:46:0	200 kg/ha
February, IIIrd decade	Urea	200 kg/ha
March, IInd decade	amidosulfuron100 g/L + iodosulfuron-methyl-sodium 25 g/L + mefenpyr diethyl 250 g/L (Sekator Progress OD)	0.15 l/ha
	cyproconazole 80 g/L + propiconazole 250 g/L (Artea)	0.40 l/ha
April, Ist decade	calcium ammonium nitrate (CAN)	150 kg/ha
May, Istdecade	tebuconazole 200 g/L + trifloxystrobin 100 g/L (Nativo Pro SC 325)	0.8 l/ha

RESULTS AND DISCUSSIONS

Agrochemical soil analysis (Table 4) indicated that soil reaction was moderately acidic for all plots, excepting plot 2 which is weak acidic. TSS values indicate a non-saline soil.

Humus contents correspond to medium level for all plots. Mobile form of phosphorus, P_{AL}, is very low for plots 3 and 4, meanwhile for plots 1 and 2 correspond to low and very low levels, respectively.

In the case of potassium content, K_{AL}, the found concentrations correspond to middle content for plots 1-3 and normal content for plot 4.

Table 4. Soil agrochemical analysis

Plot	Wheat variety	Preceding crop	pH	TSS, %	H, %	P_{AL}	K_{AL}
						mg/kg	
1	Exotic	Maize	5.73	0.0141	2.37	18.66	90
2	Solehio	Maize	6.11	0.0117	3.24	28	82
3	Exotic	Sunflower	5.66	0.0122	2.49	5.84	96
4	Solehio	Sunflower	5.60	0.0118	2.99	6.33	148

1. Results concerning yield related to preceding crop and wheat variety

The yields for both wheat varieties grown after sunflower are higher, this meaning 114.41% for Exotic and 107.25% for Solehio in comparison with those obtained using maize as preceding crop. The variance analysis concerning the influence of preceding crop on wheat yield indicates significant differences for both wheat varieties (Table 5). The influence of wheat variety on yield presents significant differences for Exotic and Solehio, with superior values given by Solehio.

Table 5. Influence of wheat variety (a factor) and of preceding crop (b factor) on yield (kg/ha)

Yield, kg/ha		
b= preceding crop / a= wheat variety	**b1** sunflower	**b2** maize
a1= Exotic	a7700a	a6730b
a2= Solehio	b6950a	b6480b
B constant A variable: LSD 5% = 154* kg/ha; LSD 1% = 297 kg/ha; LSD 0.1% = 749 kg/ha		
A constant B variable: LSD 5% = 167* kg/ha; LSD 1% = 278 kg/ha; LSD0.1% = 519 kg/ha		

There were made interpretations by LSD 5% indicated in the table by *

2. Results concerning plant height related to preceding crop and wheat variety

Wheat grown after maize presents for both varieties the highest values for plant height in comparison with those obtained using sunflower as preceding crop (Table 6). Solehio variety presented the highest values of plant height of 77 cm after maize and 76 cm after sunflower in comparison with Exotic variety.

The variance analysis regarding the influence of preceding crop on plant height indicates significant differences for Exotic, meanwhile for Solehio the differences are no significant. The influence of variety presents significant differences between Exotic and Solehio, with superior values given by Solehio.

Table 6. Influence of wheat variety (a factor) and of preceding crop (b factor) on plant height (cm)

Plant height, cm		
b= preceding crop / a= wheat variety	**b1** sunflower	**b2** maize
a1= Exotic	b67b	b70a
a2= Solehio	a76a	a77a
B constant A variable: LSD 5% = 2.19* cm; LSD 1% = 4.70cm; LSD 0.1% = 13.81cm		
A constant B variable: LSD 5% = 1.60* cm; LSD 1% = 2.65cm; LSD 0.1% = 4.97 cm		

There were made interpretations by LSD 5% indicated in the table by *

3. Results concerning spike length related to preceding crop and wheat variety

Spike lengths for both wheat varieties grown after sunflower as preceding crop are higher than those obtained after maize, this meaning differences of 14.28% (1.5 cm) for Exotic and 7.52% (0.7 cm) for Solehio (Table 7).

The variance analysis concerning the influence of preceding crop on spike length indicates significant differences for Exotic and Solehio. The influence of wheat variety present significant differences between Exotic and Solehio, with higher values given by Exotic.

Table 7. Influence of wheat variety (a factor) and of preceding crop (b factor) on spike length (cm)

Spike length		
b= preceding crop / a= wheat variety	**b1** sunflower	**b2** maize
a1= Exotic	a12a	a10.5b
a2= Solehio	b10a	b9.3b
B constant A variable: LSD 5% = 0.92* cm; LSD 1% = 2.02cm; LSD 0.1% = 6.11 cm		
A constant B variable: LSD 5% = 0.56* cm; LSD 1% = 0.93 cm; LSD 0.1% = 1.75 cm		

There were made interpretations by LSD 5% indicated in the table by *

4. Results concerning number of spikes/m^2 related to preceding crop and wheat variety

The number of spikes/m^2 in the case of both wheat varieties grown after sunflower presents superior values in comparison with those obtained after maize, the difference being identical 2.94% (15 spikes/m^2) (Table 8). The highest values were obtained for Solehio variety after sunflower and maize as well, in comparison with Exotic.

The variance analysis regarding the influence of number of spikes/m^2 indicates no significant differences for Solehio and Exotic, as well. The influence of variety presents no significant differences between Solehio and Exotic.

Table 8. Influence of wheat variety (a factor) and of preceding crop (b factor) on no of spikes/m^2

Number of spikes/m^2		
b= preceding crop / **a**= wheat variety	**b1** sunflower	**b2** maize
a1= Exotic	a525a	a510a
a2= Solehio	a535a	a520a
B constant A variable: LSD 5% = 15.30* no. spikes/m^2; LSD 1% = 26.43 no. spikes/m^2; LSD 0.1% = 54.37 no. spikes/m^2		
A constant B variable: LSD 5% = 20.43* no. spikes/m^2; LSD 1% = 33.88 no. spikes/m^2; LSD 0.1% = 63.37 no. spikes/m^2		

There were made interpretations by LSD 5% indicated in the table by *

5. Results concerning hectolitre mass (HLM) related to preceding crop and wheat variety

The values of HLM for wheat grown after sunflower are higher for Exotic and Solehio with differences of 2.75% (2.1 kg/hl) and 3.34% (2.5 kg/hl), respectively in comparison with those obtained after maize (Table 9).

The variance analysis concerning the influence of preceding crop indicates significant differences for both wheat varieties. The influence of wheat variety on HLM presents significant differences between Solehio and Exotic after Maize, with superior values for Exotic variety. After sunflower as preceding crop, the influence on HLM present no significant differences between analyzed wheat varieties.

Table 9. Influence of wheat variety (a factor) and of preceding crop (b factor) on HLM (kg/hl)

HLM, kg/hl		
b= preceding crop / **a**= wheat variety	**b1** sunflower	**b2** maize
a1= Exotic	a78.2a	a76.1b
a2= Solehio	a77.3a	b74.8b
B constant A variable: LSD 5% = 1.04* kg/hl; LSD 1% = 2.03 kg/hl; LSD 0.1% = 5.19 kg/hl		
A constant B variable: LSD 5% = 1.11* kg/hl; LSD 1% = 1.85 kg/hl; LSD 0.1% = 3.46 kg/hl		

There were made interpretations by LSD 5% indicated in the table by *

6. Results concerning thousand kernel weight (TKW) related to preceding crop and wheat variety

The highest values of TKW were obtained for both wheat varieties grown after sunflower, with differences of 14.58% (7 g) for Exotic and 11.11% (5 g) for Solehio in comparison with those obtained when preceding crop was maize (Table 10).

The variance analysis concerning preceding crop on TKW indicates significant differences for Exotic and Solehio varieties. The influence of wheat variety on TKW presents significant differences between Exotic and Solehio, with superior values given by Exotic variety.

Table 10. Influence of wheat variety (a factor) and of preceding crop (b factor) on TKW (g)

TKW, g		
b= preceding crop / **a**= wheat variety	**b1** sunflower	**b2** maize
a1= Exotic	a55a	a48b
a2= Solehio	b50a	b45b
B constant A variable: LSD 5% = 1.25* g; LSD 1% = 2.56 g; LSD 0.1% = 7.10 g		
A constant B variable: LSD 5% = 1.13* g; LSD 1% = 1.87 g; LSD 0.1% = 3.51 g		

There were made interpretations by LSD 5% indicated in the table by *

7. Results concerning wet gluten related to preceding crop and wheat variety

The values found for wet gluten parameter in the case of both wheat varieties were higher when preceding crop was maize, with differences of 1.3% for Exotic and 0.4% for Solehio in comparison with values obtained when preceding crop was sunflower (Table 11).

The variance analysis concerning the influence of preceding crop of wet gluten content indicates no significant differences for Solehio and significant differences for Exotic variety. The influence of wheat variety on wet gluten content presents no significant differences for both wheat varieties.

Table 11. Influence of wheat variety (a factor) and of preceding crop (b factor) on wet gluten (%)

Wet gluten, %		
b= preceding crop / **a**= wheat variety	**b1** sunflower	**b2** maize
a1= Exotic	a26.7b	a28.0a
a2= Solehio	a27.0a	a27.4a
B constant A variable: LSD 5% = 0.74* % ; LSD 1% = 1.52%; LSD 0.1% = 4.25%		
A constant B variable: LSD 5% = 0.66* % ; LSD 1% = 1.09%; LSD 0.1% = 2.04%		

There were made interpretations by LSD 5% indicated in the table by *

8. Results concerning crude protein related to preceding crop and wheat variety

The highest values of crude protein contents were found for both wheat varieties grown after maize but with no significant differences of

0.7% for Exotic and 0.1% for Solehio in comparison with those found for wheat grown after sunflower (Table 12).

The variance analysis concerning the influence of preceding crop on protein content presents no significant differences for Exotic and Solehio varieties. Also, the influence of wheat variety on protein content presents no significant differences between Solehio and Exotic with close values between wheat varieties.

Table 12. Influence of wheat variety (a factor) and of preceding crop (b factor) on crude protein (%)

Crude protein, %		
b= preceding crop / **a**= wheat variety	**b1** sunflower	**b2** maize
a1= Exotic	a12.5a	a13.2a
a2= Solehio	a12.9a	a13.0a
B constant A variable: LSD 5% = 0.69* %; LSD 1% = 1.23%; LSD 0.1% = 2.70%		
A constant B variable: LSD 5% = 0.88* %; LSD 1% = 1.46%; LSD 0.1% = 2.74%		

There were made interpretations by LSD 5% indicated in the table by *

CONCLUSIONS

The research carried out during 2017-2018 in Morteni Commune, Dambovita County with the purpose of investigation for Exotic and Solehio wheat varieties the variability of yield components and quality parameters influenced by preceding crops and by wheat variety generated the conclusions presented below.

1. A significant influence upon the wheat yield, spike lengths, number of spikes/m^2, HLM and TKW parameters was registered under sunflower as preceding crop.

2. Among the two preceding crops, maize determined higher values upon the wheat quality components, wet gluten and crude protein.

3. The highest yield, 7700 kg/ha, was recorded for Exotic after sunflower, and the lowest, 6480 kg/ha, was found for Solehio after maize.

4. Solehio variety presented the highest values of plant height of 77 cm after maize and 76 cm after sunflower in comparison with Exotic variety.

5. Spike lengths for both wheat varieties grown after sunflower as preceding crop are higher than those obtained after maize, this meaning differences of 14.28% (1.5 cm) for Exotic and 7.52% (0.7 cm) for Solehio.

6. The highest values of number of spikes/m^2 were obtained for Solehio variety after sunflower and maize as well, in comparison with Exotic (535 and 520, respectively).

7. The highest HLM value, 78.2kg/hl, was found for Exotic variety grown after sunflower and the lowest was recorded for Solehio after maize, 74.8 kg/hl.

8. The highest values of TKW were obtained for both wheat varieties grown after sunflower: 55 and 50 g, respectively with differences of 7 and 5 g, respectively, in comparison with maize as preceding crop.

9. Wet gluten and crude protein contents were higher for both wheat varieties in the case of maize as preceding crop with close differences between varieties.

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