The Influence of Soil Fertility and Precursor Plant on *Triticosecale* Crop Production

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Abstract
As a result of the intercross between wheat - *Triticum* and rye – *Secale*, Triticale - *Triticosecale* is a new variety of grains, used as fodder, which is cultivated on different soil types and in different climate conditions around the world. By intergenetic crossing, the species has obtained both the rusticity of rye and the productivity of wheat. Through the studies and researches carried out in the last years, in the Mureș-Crișul Alb interfluve area, more specifically the Arad Plain landform, it has been persued the behaviour of this species, on different soils, in terms of fertility and texture. Under the same cultivation conditions, two different genetic materials have been tested – the native Haiduc variety, as well as a variety from Hungary. Also, the precursor plants chosen for the two cultivation variants, one of the legumes, respectively lucerne and an oleaginous species commonly for the reference area - autumnal rape, proved to be representative for the cultivation of triticale. The main physical, hydrophysical and chemical properties of the two studied soils, combined with a balanced level of fertilization, significantly influenced the production of grains in the triticale crop and the differences were observed mainly due to soil texture and precursor plant. Still, it is important to highlight that the variations in production were determined by a complete series of factors such as soil fertility, the genetic material used, the precursor plant and the climate conditions of the agricultural year. The average harvest over the three years of cultivation, for all of the varieties was close to 6 t / ha. Among these agricultural years, the period between the years 2018-2019 stood out, as the production exceeded 6 t / ha, having, more precisely, a value of 6.021 kg / ha. Regarding the fertility of the two soils, it has been observed an excedent of about 5% in the productions obtained on the typical chernozem soil type.

Keywords: fertility, production, soil, Triticosecale, variety.

1. Introduction

The triticale species is a new variety of cereal from the *Poaceae* botanical family, which has appeared as a result of the hybridization between wheat and rye, respectively *Triticum* and *Secale*. By making this new species, the combination of some characteristics such as the rusticity of rye and the quality of wheat in a single organism it has been succeeded, however, when used in used in panification, triticale presents inferior properties to wheat but if used in animal feed, it has some remarkable qualities [1, 2]. In animal feed, the grains are the most used, as their feed value is almost at the same level as the feed value of wheat grains, mainly due to their high protein and lysine content. These characteristics make triticale grains superior to other cereals, especially for their use in poultry and pig feed [3, 4]. With its expansion in culture, the utilization in animal feed of this plant has increased, also as silage and green fodder, especially near livestock farms. Usually, for this purpose, the autumn forms are cultivated, as they are more productive compared to the spring ones, the amount of green mass obtained exceeding the value of 40 t / ha [1, 2, 5].

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To increase the quality of fodder, triticale can be cultivated in a mixture with a legume, forming the autumn or spring mash, successfully used in the nutrition of many species of animals, both as a green fodder and grains [3, 4].
A special advantage of cultivating this species is the agro-phytotechnical characteristic, triticale being a very good crop rotation plant for most agricultural crops [7, 8]. At the same time, unlike wheat and rye, the plant uses in a better way, different soils in terms of texture and fertility, but also poorer, acidic or alkaline, sandy and lighter.

2. Materials and methods

From a geomorphological point of view the research area is located in the great physical-geographical unit in the Western part of Romania, respectively "The Banat-Crișana Plain". According to some authors this territory represents the Mureș-Crișul Alb interfluve area, with a variety of geological formations and several geomorphological units, the most important being represented by the Arad Plain [6]. From the specialized literature on climatic conditions, it appears that the studied area is characterized by a temperate continental climate with oceanic and sub-Mediterranean influences. Referring to the natural vegetation, within the studied territory, the specific flora is characteristic for the plain area, with agricultural lands and steppe meadows (*Festuca sulcata, Festuca pseudovina, Crysopogon grylus, Cynodon dactylon*, etc.) [9]. The research material used in the three experimental years between 2019-2021, included the Romanian, autumnal variety of triticale - Haiduc, created by the Fundulea Agricultural Research-Development Institute (INCDA) and Provenance – a variety from Hungary [10]. The two varieties are similar, having good resistance to low winter temperatures, as well as cropper, with deep rooting and a more elastic straw. Both species also present a remarkable resistance to ear fusarium wilt and septariosis, medium resistance to rust and, also, good quality traits for animal feed, either as concentrated feed or silage, as green fodder (cattle, sheep) or as grains for the bird and pig feed.

Table 1. Typical chernozem, moist wet, medium clay, dusty clay / medium clay

HORIZONS	UM	Ap	Atp	AM	A/C	C/A	Ccag1	Ccag1	Ckg2
depth	cm	18	35	55	75	100	125	158	195
Coarse sand (2.0 - 0.2 mm)	%	4.3	3.5	2.4	1.9	2.1	4.1	4	3
Fine sand (0.2 - 0.02)	%	29.6	37	37.2	36.2	38.6	44.2	47.1	42.9
Dust (I + II) (0.02-0.002 mm)	%	39.4	27.6	28.6	30.4	30.6	24.7	31.6	37
Colloidal clay (less than 0.002)	%	26.7	31.9	31.8	31.5	28.7	27	17.3	17.2
Physical clay (powder II + arg col)	%	50.7	48.9	55.4	49.6	43.9	39.1	36.3	31.3
TEXTURE		LP	II	II	II	II	II	SM	SS
Specific density (Ds)	g/cm3	2.6	2.61	2.62	2.62				
Bulk density (Yes)	g / cm3	1.54	1.6	1.49	1.36				
Total porosity (Pt)	%	41	42	43	48				
Degree of settlement (Gt)	%	17.4	15.3	14.6	4.1				
Hygroscopicity coefficient (CH)	%	12.1	11.6	13.2	11.8				
Withering coefficient (CO)	%	18.1	17.5	19.8	17.7				
Field capacity (CC)	%	25.1	25.5	25.7	25.5				
Useful water capacity (CU)	%	7	8	5.9	7.8				
pH in water		6.1	6.25	6.5	7.15	7.8	8.1	8.2	8.3
Carbonates (CaCO3)	%					7.1	12.6	13.8	10.8
Humus	%	3.3	2.8	2					
Nitrogen index (IN)		3.3	2.8	2					
Reserve humus		915	71.4	44.7		208			
P mobile	ppm	14.3	11.8	10.1					
K mobile	ppm	190	200	155					

Source: Archive - Arad Office of Pedological and Agrochemical Studies

Table 2. Eutricambosoil weakly glayzed, on medium-fine fluvial deposits clay-dusty clay / clay-dusty clay

HORIZONS	UM	Ap	Atp	AB	Bvg1	BCkg1	Ckg2
depth	cm	25	50	75	98	130	180
Coarse sand (2.0 - 0.2 mm)	%	3.9	3	3.9	1.6	2.4	1.8
Fine sand (0.2 - 0.02)	%	24.9	24.6	19	23.9	24.6	28.9
Dust (I + II) (0.02-0.002 mm)	%	36.8	33.8	41.3	33.5	35.7	42.8
Colloidal clay (less than 0.002)	%	34.4	38.6	35.8	41	37.3	26.5
Physical clay (powder II + arg col)	%	57.1	60.2	62.6	63.3	57.7	53.1
TEXTURE		TP	TP	TP	TP	TP	LP
Specific density (Ds)	g / cm3	2.6	2.63	2.63			
Bulk density (Yes)	g / cm3	1.5	1.55	1.57			
Total porosity (Pt)	%	42	41	40			
Degree of settlement (Gt)	%	16.4	19.9	20.7			
Hygroscopicity coefficient (CH)	%	13.9	14.7	15.2			
Withering coefficient (CO)	%	20.9	22	22.8			
pH in water		5.75	6.4	6.7	7.15	8.1	8.4
Carbonates (CaCO3)	%					10.4	13.6
Humus	%	2.65	2.5	1.85			
Nitrogen index (IN)		1.56					
Reserve humus		99.4	96.9		196		
P mobile	ppm	30.5	10.7	11.5			
K mobile	ppm	two hundred	175	190			
Exchange bases (SB)	me / 100	6.4					
Exchangeable H (SH)	me / 100	6.6					
Gr saturation in bases (V)	%	59					
Mobile aluminum	me / 100	0.02					

Source: Archive - Arad Office of Pedological and Agrochemical Studies

The research was carried out in the period between 2019-2021, for the autumn forms cultivated on two different soils: typical chernozem (Table 1) and eutricambosoil weakly glayzed (Table 2), in terms of texture, soil reaction, humus reserve and nitrogen index, as analyzed based on their horizonts and detailed in the tables. Also, the precursor plants, namely lucerne and autumn rape are frequently used by farmers in this area.

The fertilization of the soil was done uniform, by applying organic fertilizers (manure), as well as chemical fertilizers, with the following dosage: 70 kg / ha N, 60 kg / ha P_2O_2 and 50 kg / ha K_2O.

The other elements of the crop's technology were the same as for those used for fall straw cereal crops.

The main purpose of the research was the identification of the most favourable elements of cultivation (soil, precursor plant, genetic material, vegetation factors, fertilizers used) that would lead to high productions of grains, as well as an increased quality of the grains.

Among the **objectives** we list the behaviour of the genetic material depending on the characteristics of the soil and the influence of the precursor plant on the production capacity.

3. Results and discussion

Results of the year of 2019

The results regarding the production of grains in the triticale crop, obtained in the agricultural year of 2018-2019 (Table 3), indicate a very good behaviour of Haiduc variety, cultivated on a typical chernozem soil, with good quality characteristics, after lucerne as a precursor plant. Under these conditions, it was registered the highest amount of grains, respectively 6374 kg / ha, exceeding the average of the eight variants by 353 kg / ha, which represents an increase of 6%. Likewise, a good behaviour was obtained by *Haiduc* variety, also after lucerne, on the other type of soil, respectively eutricambosoil, even if the reaction of this soil is a moderate-acidic one, and the texture is a little more clayey. The

differences between the two cultivation variants were by only 235 Kg / ha, meaning a lower value of 4% compared to the average. Regarding the variety *Provenance from Hungary*, it can also be appreciated a good behaviour of this variety on the two soil types, however, it was observed an additional amount of grains in the cultivation of this species on the typical chernozem soil type and after lucerne as a precursor plant. The average of the variants studied under the aspect of the productions obtained, shows that there were good natural and cultivation conditions in the reference year, through the value of over 6 t / ha of grains obtained in both cases.

Table 3. Production results of grains in the year of 2019

Soil type	Genetic material	Precursor plant	Production kg/ha	Production %	Difference from the average kg/ha	Difference from the average %
Typical Chernozem	Haiduc variety	Lucerne	6374	106%	353	6%
		Autumnal rape	5987	99%	-34	-1%
	Hungarian variety	Lucerne	6143	102%	122	2%
		Autumnal rape	5768	96%	-253	-4%
Eutricambosoil weakly glayzed	Haiduc variety	Lucerne	6139	102%	118	2%
		Autumnal rape	5878	98%	-143	-2%
	Hungarian variety	Lucerne	6017	99,04%	-4	-0.06%
		Autumnal rape	5863	97%	-158	-3%
Average production of variants kg/ha			6021	100%	0	0%

Results of the year of 2020

In the climatic conditions of this year of cultivation of triticale crops, the results were different, being influenced a bit more by the precursor plant. Thus, lucerne proved to be, in all variants, superior to autumn rape, the peak being recorded in Haiduc variety cultivated on the typical chernozem soil type, with an increased production of 312 kg / ha, compared to the average of the variants. In antithesis, the Hungarian variant cultivated on the eutricambosoil soil type, after the autumn rape, obtained a lower production, with a minus of 267 kg / ha.

From the analysis of the average of the variants, it can be observed the good behaviour of the genetic material used, in the cultivation conditions of this year, through the amount of 5814 kg / ha, STAS grains obtained (Table 4).

Table 4. Production results of grains in the year of 2020

Soil type	Genetic material	Precursor plant	Production kg/ha	Production %	Difference from the average kg/ha	Difference from the average %
Typical Chernozem	Haiduc variety	Lucerne	6127	105%	312	5%
		Autumnal rape	5716	98%	-98	-2%
	Hungarian variety	Lucerne	5904	102%	90	2%
		Autumnal rape	5611	97%	-203	-3%
Eutricambosoil weakly glayzed	Haiduc variety	Lucerne	6083	105%	296	5%
		Autumnal rape	5695	98%	-119	-2%
	Hungarian variety	Lucerne	5865	101%	51	1%
		Autumnal rape	5547	95%	-267	-5%
Average production of variants kg/ha			5814	100%	0	0%

Results of the year of 2021

In the agricultural year of 2020-2021 the climatic conditions recorded were favourable for the cultivation of autumn triticale. The differences compared to the average of the variants were within the value margin of 10% (Table 5).

The behaviour of the two varieties in terms of grains production was close, even if the soils have different characteristics and the precursor plants were not the same.

The difference between the first variant (6241 kg / ha) and the last one (5749 kg / ha) was 492 kg / ha, thus exceeding a percentage of over 8%. The average grain production of all variants was very close to the value of 6000 kg / ha.

Table 5. Production results of grains in the year of 2021

Soil type	Genetic material	Precursor plant	Production kg/ha	Production %	Difference from the average kg/ha	Difference from the average %
Typical Chernozem	Haiduc variety	Lucerne	6241	105%	270	5%
		Autumnal rape	5938	99%	-32	-1%
	Hungarian variety	Lucerne	6107	102%	137	2%
		Autumnal rape	5819	97%	-151	-3%
Eutricambosoil weakly glayzed	Haiduc variety	Lucerne	6115	102%	145	2%
		Autumnal rape	5859	98%	-111	-2%
	Hungarian variety	Lucerne	5937	99%	-33	-1.00%
		Autumnal rape	5749	96%	-221	-4%
Average production of variants kg/ha			5970	100%	0	0%

Synthesis of productions between 2019-2021

The average of the three experimental years (Table 6) presents as the best variant the cultivation of the local variety of triticale – *Haiduc* - on the typical chernozem type of soil, having lucerne as a precursor plant. Therefore, the production obtained in this case had the highest value of 6247 kg / ha.

The typical chernozem proved to be the most favorable type of soil for the cultivation of *Haiduc* variety of triticale, while in the case of the entricambosoil weakly glayzed, with a slightly lower fertility, but with the same precursor plant, the grain production was also quite high, exceeding the value of 6100kg / ha.

Regarding the genetic material used, there was observed a difference between the varieties, resulting in the productions reported.

As for the precursor plant, lucerne, which is a legume species that contributes significantly to an additional supply of atmospheric nitrogen in the soil, has led to an increase in yield compared to rapeseed [2, 3, 11].

By working out an average of all crop variants, it was obtained a value of 5936 kg / ha, which means a very good production in the natural conditions existent in the Arad Plain.

Therefore, from the synthesis obtained during the three years of triticale cultivation on soils with good to very good fertility (typical chernozem and eutricambosoil weakly glayzed), there were observed significant differences between the variants, determined by the cultivated triticale variety and the precursor plant.

Table 6. Synthesis of productions between 2019-2021

Soil type	Genetic material	Precursor plant	Production kg/ha	Production %	Difference from the average kg/ha	Difference from the average %
Typical Chernozem	Haiduc variety	Lucerne	6247	105%	310	5%
		Autumnal rape	5879	99%	-57	-1%
	Hungarian variety	Lucerne	6051	102%	115	2%
		Autumnal rape	5739	97%	-197	-3%
Eutricambosoil weakly glayzed	Haiduc variety	Lucerne	6112	103%	176	3%
		Autumnal rape	5804	98%	-132	2%
	Hungarian variety	Lucerne	5939	100,05%	3	0,05%
		Autumnal rape	5719	96%	-217	-4%
Average production of variants kg/ha			5936	100%	0	100%

4. Conclusions

The studied area, namely the Arad Plain in the Mureș-Crișul Alb interfluve, is considered as favorable for field crops, especially straw cereals. The dominant soils in the reference area are chernozems and eutricambosoils with good fertility, requiring agricultural work in the optimal periods, in order to obtain the most profitable results.

The experimental years were different in terms of some vegetation factors such as temperatures and monthly precipitation, but these proved to be favourable for plant growth and development.

The testing of the two varieties was inspired, as both performed well under cultivation conditions, achieving high productions.

We can conclude that all the observed cultivation conditions (soil type, precursor plant, genetic material, vegetation factors, fertilizers used) contributed to the results obtained, but certainly the precursor plant, lucerne, had the greatest influence, being superior in all variants.

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