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Original Article

Influence of Technological and Biotic Factors on some Elements of the Maize Production Grown in the Classical System and with Minimum Tillage at ARDS Turda

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Abstract

Minimum tillage systems on soil have become in the last time a necessity as a result of global climate change. The main plant cultivation measure, however, influence also the intensity of *Fusarium* infection, being recomanded to optimize tillage systems to control these infections. Maize culture in minimal systems creates optimal conditions to develop and maintain in culture more specific pests. The productions obtained in the two soil systems are near, the difference in production indicating the need for a work (mobilization) of soil being necessary to slaughter in the spring, before sowing, at maize culture..

Keywords: soil tillage systems, fertilization, treatments, *Fusarium*, pests, climate conditions.

1. Introduction

The climate changes taking place both locally and globally require the adoption of new agricultural technologies as more appropriate to the new climatic conditions [9]. The first research in order to reduce the number of works have been conducted in the Michigan, Ohio şi New York states in the USA, at maize culture. Agricultural system with minimal soil works it became one of the most used systems in agriculture due to its efficiency in reducing the time required and the costs, through its implementation realizing the fuel economy up to 73% [4].

For reducing fuel consumption and to avoid increased soil subsidence through repeated machines passing on the ground that lead to the worsening of the physical properties of soil, it acts in the direction the number of soil works or to perform, in a single pass, a multiple operations through minimum system works [11].

Work the soil, fertilizing and plant protection (pests and diseases) [12], [6], [7], in interaction with other important factors (variety, climatic conditions) have direct influence on production and quality of crop plants [3] [8]. The production obtained in the application of minimum tillage system soil is the result of improving the natural fertility of the soil by increasing the quantity of organic matter in soil [10].

Following research carried out shows that maize is pretentious towards the work of the soil, soil type, climatic conditions, the production results confirming this [1].

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Research conducted confirms that the work which include plowing have a major impact on the soil structure and fertility [2], uncovered soil is exposed to rainfall and the wind which accentuates the erosion processes, reducing productivity and quality [5].

2. Material and Method

The seeding was realized with the drill Gaspardo MT-6, for processed or with minimal processing land, with 6 rows, the distance between rows of 70 cm, at a density of 70000 plants/ha.

The experience was realized at ARDS Turda, over a period of 3 years, is a poly-factorial experience, with four factors:

Factor A: system of soil work, 2 graduation: A1: classic (plowing with return of furrow); A2: unconventional (processing with chisel).

Factor B: fertilization, 2 graduation: B1: $N_{40}P_{40}$ applied simultaneously with the sowing; B2: $N_{40}P_{40}$ applied simultaneously with the sowing + N40 applied in phenophase of 4-6 leaves.

Factor C: treatments applied to vegetation in two important phenological moments of the vegetation period of maize, 4 graduation.

The scheme of treatments application is presented in table 1.

Factor D: years take in study, 3 graduation, D1: 2009; D2: 2010; D3: 2011.

The climatic conditions in the three years taking in the study are listed in table 2 and table 3.

Table 1.The scheme of treatments application

Variant of treatment	Phenophase of 3-5 leaves	Phenophase of 7-8 leaves
C1	FF + IS	FF + IS
C2	FF + IS	FF
C3	FF	FF
C4	FF	-

FF= Foliar Fertilizer Polyfeed (5 kg/ha); IS= Insecticide Calypso (0.1 l/ha)

Table 2. Thermal regime at Turda in the period 2009-2011

Years/ month	Monthly average temperature (^{O}C)												Annual average
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
2009	-2.3	-0.5	3.7	13.2	16.2	18.7	21.0	20.7	17.4	10.0	5.2	0.1	10.3
2010	-3.1	1.0	4.3	10.5	15.4	18.9	20.7	21.0	14.2	7.4	7.6	-1.6	9.7
2011	-3.8	-3.2	5.3	10.7	15.6	19.2	20.1	20.8	18.2	8.8	0.7	0.8	9.4
Average 57 years	-3.5	-0.9	4.1	9.9	14.8	17.8	19.7	19.3	15.0	9.6	3.8	-1.5	9.0

From the data presented in table 2 it can be seen that the temperatures recorded in his three years taking in study are higher than the average 57 years, the hottest year being considered 2009, when are registered an average annual temperature of 10.3^{0}C, with 1.3^{0}C higher than average temperatures on the 57 years, 2010 and 2011 are considered normal in terms of thermal.

Table 3.Pluviometric regime at Turda in the period 2009-2011

Years/ month	Monthly amount precipitation (mm)												Annual amount
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
2009	9.5	22.4	53.5	8.4	31.4	113.4	52.5	38.1	3.4	77.8	48.0	35.0	493.4
2010	39.2	30.6	17.6	52.0	87.6	172.6	121.0	49.2	67.2	31.6	30.8	40.4	739.8
2011	26.8	19.9	15.3	22.6	41.4	116.8	130.4	12.8	22.8	8.8	0.2	15.2	433.0
Average 57 years	21.4	18.8	23.4	45.4	68.3	84.2	75.6	55.2	40.4	32.8	28.0	26.9	520.6

Value of precipitation in the years 2009 and 2011 are lower than the average of 57 years, being considered a little dry-year 2009, respectively very dry-2011.

The amount of precipitation in the year 2010, is much higher than the average of 57 years, the value of 739.8 mm characterizing the year as being excessively wet.

Also was follow and the effect of pests and diseases in the two soil tillage systems. Observation were made on the degree of strain and cob fusariosis attack, completing with the rattings and the

evolution of the most important pests registered on the sex pheromone traps (*Ostrinia nubilalis, Diabrotica v. virgifera, Agrotis segetum, Autographa gamma*).

3. Results and Discussions

Compared to the classic system, considered control variant, in variants with conservative system, the percentage of broken and rotten plants was much higher, the differences are very significant.

Additional fertilization with nitrogen has increased the percentage of broken plants, the differences were not statistically assured but also increase the percentage of rotten plants differences being distinct significant positive.

Regarding treatments applied, foliar fertilizer variants is noted with lower values of percentage of broken plants with very negative significant differences.

The application of two treatments with foliar fertilizer in two stages of vegetation has increased the percentage of rotten plant, values are highly significant statistically assured.

The manifestation degree of broken and rotting plants was different in the years of experimentation.

The percentage of broken plants was higher in 2011 to 1.58% in absolute terms, the difference from the average of the years is significantly positive.

The year 2009 saw the highest percentage of rotten plants 10.07% and in 2010 and 2011 plants were less rotten 4.56% and 4.27%.

Factors	Fusarium stalk rot						Fusarium ear rot		
	Broken plants			Rotten plants					
	%	arcsin √%	d.	%	arcsin √%	d.	%	arcsin √%	d.
A. System of soil work									
Classic (control)	8.78	17.26	0.00	3.82	11.24	0.00	1.02	5.74	0.00
Minimum tillage	14.95***	22.71	6.17	8.78***	17.26	4.97	2.21***	8.53	1.19
LSD 5%			0.52			0.64			0.11
LSD 1%			0.78			0.96			0.17
LSD 0.1%			1.26			1.55			0.27
B. Fertilization									
$N_{40}P_{40}$ (control)	11.62	19.91	0.00	5.97	14.06	0.00	1.48	7.04	0.00
$N_{40}P_{40}$+ N_{40}	12.11	20.36	0.49	6.63**	14.89	0.67	1.74***	7.49	0.26
LSD 5%			0.50			0.46			0.09
LSD 1%			0.71			0.64			0.13
LSD 0.1%			1.00			0.91			0.18
C. Treatments application									
C1 (control)	13.09	21.22	0.00	5.99	14.18	0.00	1.67	7.49	0.00
C2	12.21^{0}	20.44	-0.88	6.02	14.18	0.02	1.79*	7.71	0.12
C3	11.41^{000}	19.73	-1.69	7.27***	15.68	1.28	1.69	7.49	0.02
C4	10.76^{000}	19.19	-2.33	5.92	14.06	-0.07	1.31^{000}	6.55	-0.36
LSD 5%			0.78			0.43			0.11
LSD 1%			1.03			0.57			0.15
LSD 0.1%			1.34			0.74			0.19
D. Years									
Average (control)	11.87	20.18	0.00	6.30	14.54	0.00	1.61	7.27	0.00
2009	11.01	19.37	-0.86	10.07***	18.53	3.76	1.64	7.27	0.03
2010	11.15	19.55	-0.72	4.56^{00}	12.39	-1.74	1.36^{00}	6.80	-0.25
2011	13.44*	21.47	1.58	4.27^{00}	11.97	-2.03	1.84**	7.71	0.22
LSD 5%			1.41			1.01			0.12
LSD 1%			2.33			1.66			0.21
LSD 0.1%			4.36			3.12			0.38

Table 4. Summary of degree manifestation of fusariosis diseases attack (*Fusarium* spp.) in relation to soil tillage system, the levels of fertilization and treatments applied to the Turda Favorit hybrid in 2009-2011

Soil tillage in conservative system very significantly has influenced the percentage of diseased kernels compared to the classic version considered control, the percentage of fusariosis on the ear increasing from 1.02% to 2.21%. Fertilization levels influenced very significantly positive degree fusariosis attack on the ear. Between the four treatment options, which consisted of applying foliar fertilizers and insecticides, were identify significant differences positive version two applications of foliar fertilizer and insecticide application compared to witness. When applying foliar fertilizer once in the 3-5 leaf phenological stage, percentage of fusarium ear rot was the lowest with very significant differences negative compared to control.

Analyzing the summary of the degree manifestation of fusariosis attack on cob (*Fusarium* spp.) in the three experimental years 2009-2011 in relation to soil tillage system, the levels of fertilization and treatment at the Turda Favorit hybrid, it follows that the percentage of diseased kernels was influenced by climatic conditions, so from the average in 2010 there were distinct significant negative differences and in 2011 the percentage of diseased kernels difference between classic and conservative was 0.22%, differences are distinct significant positive.

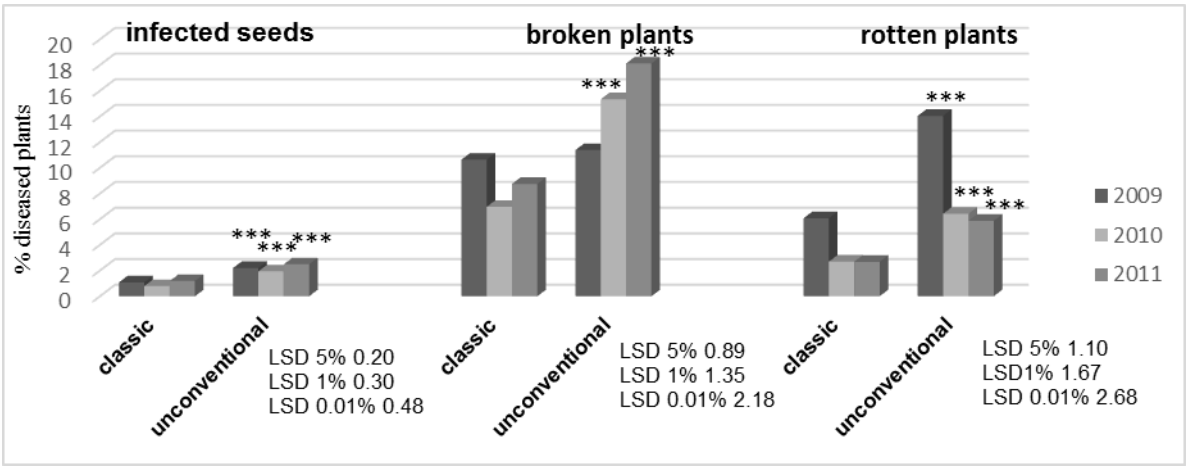

Figure 1. The influence of tillage system on the stalk and ear fusariosis at Turda Favorit hybrid in 2009-2011

In the three years of experimentation both in terms fusarium ear rot and fusarium stalk rot the percentages were higher with very significant positive differences statistically assured.

Concerning monitoring pests, notice a slightly higher abundance in soil tillage systems (with chisel), compared to the classical system, in the years included in the study, at species: *Diabrotica v. Virgifera, Ostrinia nubilalis* and *Agrotis segetum* (Table 5). Both in conventional tillage system (plowing) and with minimal tillage system (chisel), the flight of *Ostrinia nubilalis* adults is present in corn crop, since the first decade of June, registering maximum flight in July, with higher abundance in minimal tillage system, and the maximum flight of *Diabrotica v. Virgifera* adults was recorded in both tillage systems in the third decade of July, with higher abundance in minimal tillage system.

The other two species, *Agrotis segetum* and *Autographa gamma*, presented maximum flight in June and August, with a higher number in system with minimal tillage (with chisel) (Table 6, Figure 2).

Table 5. Monitoring of the most important pests (lepidoptere, coleoptere), the synthetic sex pheromone traps of maize crop, in both tillage systems (plowing and with chisel) ARDS Turda, 2009-2011

Year	2009		2010		2011		TOTAL	
Pest	Plowing	With chisel	Plowing	With chisel	Plowing	With chisel	Plowing	With chisel
Ostrinia nubilalis (European Corn Borer)	84	94	121	123	118	160	323	377
Diabrotica v. Virgifera (Western corn Rootworm)	121	153	97	137	112	117	330	407
Agrotis segetum (Turnip moth)	72	75	89	101	68	117	229	293
Autographa gamma (Silver Y)	55	79	74	81	63	67	192	227

And the repartition percentage (%) of insect species sex pheromone traps monitored in two tillage systems, plowing and with chisel, it results that the proportion of spread is between from 11.0 to 38.4% in the classic and from 11.4 to 34.6% in system with minimal tillage of the soil. Compared with the classic system, stands out that the species *Diabrotica v. Virgifera* (20.4%), followed by *Ostrinia nubilalis* (18.9%) and then *Agrotis segetum* and *Autographa gamma* (26.1%) have a slightly higher percentage repartition in system with minimal tillage (Table 7).

Watching it and the attack frequency (%) of *Ostrinia nubilalis* in 2010 and 2011 in both tillage systems, it can be seen in Figure 2, that the values have been higher attack in minimal tillage system (Figure 3).

Progress in the field of machinery, agrotechnics (through alternative fertilizing and disease, pests and weeds control) supported the implementation of minimum tillage system, thus obtaining productions close to the classic system, the difference of-18 kg/ha obtained in the soil tillage with chisel being insignificant (Table 8).

The weight of 1000 grains (TKW) was influenced by the tillage system, in variant with chisel the difference being significant negative compared with control. Hectolitre weight not being influenced by the tillage system, difference compared with control being insignificant.

Table 6. The abundance of corn pest in the conventional and minimal tillage, registered at sex pheromone traps in the period June-August at ARDS Turda

Pest / The period monitoring (decades)	*Ostrinia nubilalis* (European corn borer)		*Diabrotica v. Virgifera* (Western Corn Rootworm)		*Agrotis segetum* (Turnip moth)		*Autographa gamma* (Silver Y)	
	Plowing	With chisel	Plowing	With chisel	Plowing	With chisel	Plowing	With chisel
10 June	3	7	0	0	5	3	7	3
20 June	12	10	0	0	15	11	5	8
30 June	35	38	0	0	31	43	35	27
10 July	72	72	22	14	35	22	26	9
20 July	62	113	61	82	37	55	34	66
30 July	51	44	121	223	22	27	14	11
10 August	40	42	60	55	59	95	44	63
20 August	22	29	54	28	19	11	14	19
30 August	26	22	12	5	4	26	13	21
Total	323	377	330	407	229	293	192	227
General total	700		737		522		419	

Table 7. Repartition percentage (%) of insect species monitored at sex pheromone traps in both tillage systems in maize crop at ARDS Turda, 2009-2011

Nr. Crt.	The species caught in the sex pheromone traps	Abundance (A)		Dominance (D%)	
		Plowing	With chisel	Plowing	With chisel
1.	*Ostrinia nubilalis* (European Corn Borer)	323	377	18.5	18.9
2.	*Diabrotica v. Virgifera* (Western corn Rootworm)	330	407	18.9	20.4
3.	*Agrotis segetum* (Turnip moth)	229	293	13.1	14.7
4.	*Autographa gamma* (Silver Y)	192	227	11.0	11.4
5.	Other species	670	690	38.4	34.6
6.	Total	1744	1994	100.0	100.0

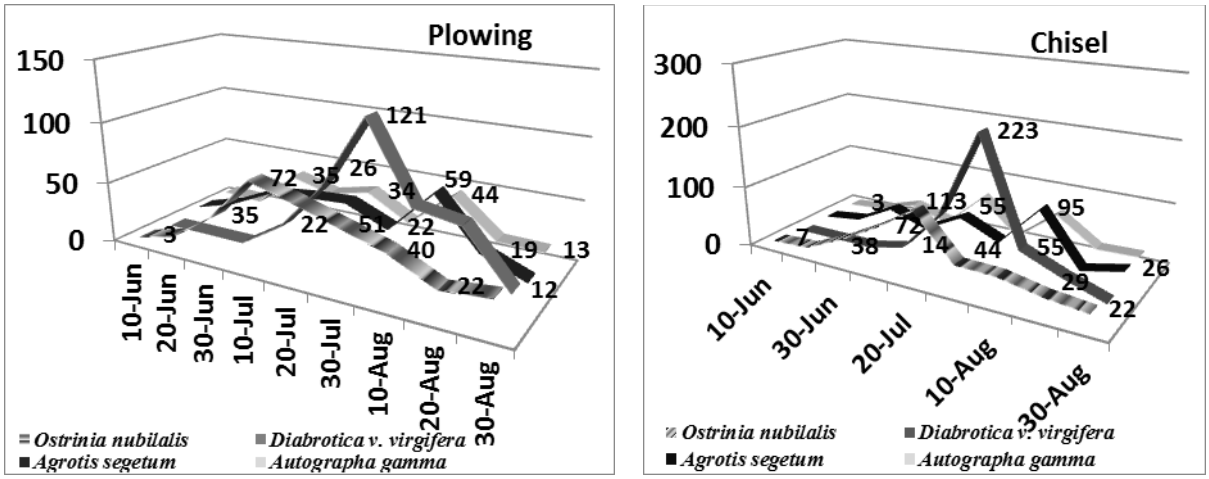

Figure 2. Flight dynamics of maize crop pests in both tillage systems in the period June-August (ARDS Turda, 2009-2011)

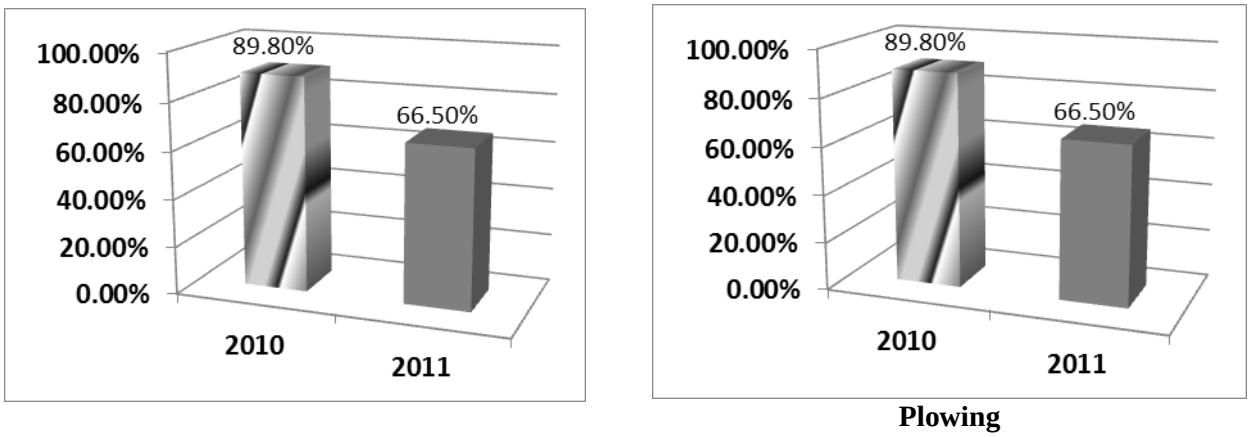

Figure 3. Frequency attack to *Ostrinia nubilalis* Hbn. at hybrid maize Turda Favorit in 2010 and 2011 in both tillage systems of soil (plowing and chisel)

Table 8.Influence of soil tillage system on elements production at Turda Favorit hybrid, 2009-2011

Variant		Yield (kg/ha)	TKW (g)	HW (kg/hl)
Plowing (control)	Value	5479	265.9	69.88
Chisel	Value	5460	260.38^{0}	69.69
	Difference	-18	-5.52	-0.19
LSD	5%	191	2.50	0.19
	1%	442	5.78	0.45
	0.1%	905	18.40	1.42

Table 9.Influence of fertilization on elements production at Turda Favorit hybrid, 2009-2011

Variant		Yield (kg/ha)	TKW (g)	HW (kg/hl)
$N_{40}P_{40}$ at sowing (control)	Value	5167	258.23	69.90
$N_{40}P_{40}$ at sowing + N_{40} in phenophase	Value	5771***	268.04***	69.66^{00}
of 4-6 leaves	Difference	604	9.81	-0.25
LSD	5%	44	2.21	0.08
	1%	73	3.66	0.14
	0.1%	136	6.86	0.25

Additional fertilizing an increase production of 604kg/ha, very significant positive difference compared with basic fertilizing applied in the same time with sowing. Results very significant positive obtained at the weight of 1000 grains (TKW) by applying additional fertilizing, but the hectolitre weight was influenced distinctly significant negative compared with control (Table 9).

Table 10. Influence of treatments on elements production at Turda Favorit hybrid, 2009-2011

Variant		Yield (kg/ha)	TKW (g)	HW (kg/hl)
C1 (control)	Value	5449	261.08	69.93
C2	Value	5438	268.72^{***}	69.67^{0}
	Difference	11	7.65	-0.26
C3	Value	5409	257.12^{000}	69.40^{000}
	Difference	40	-3.96	-0.52
C4	Value	5328^{000}	265.63^{***}	70.13
	Difference	121	4.56	0.20
LSD	5%	63	2.06	0.22
	1%	86	2.80	0.29
	0.1%	115	3.75	0.39

Application of treatments and foliar fertilizer during the growing season has not influenced productions of the two variants of C2 and C3 (with fertilizer applied in two moments and insecticide in 3-5 leaves) compared to the control, to which has been applied both insecticide and foliar fertilizer in two phenological moments, very significant negative differences in the variant were applied insecticide at 3-5 leaves (Table 10).

In the variant which foliar fertilizer has been applied in two phenological moments, differences were obtained are very significant negative at the weight of 1000 grains (TKW) hectolitre weight, and to variant which was applied insecticides and foliar fertilizer to weight of 1000 grains (TKW) increased by 7.65 g, very significant difference compared to the control.

Table 11. Influence of climatic condition on elements production at Turda Favorit hybrid, 2009-2011

Variant		Yield (kg/ha)	TKW (g)	HW (kg/hl)
Average years (control)	Value	5469	263.14	69.78
2009	Value	5398^{00}	268.73***	74.66***
	Difference	-72	5.59	4.88
2010	Value	6786***	275.81***	68.36^{000}
	Difference	1317	12.68	-1.42
2011	Value	4224^{000}	244.86^{000}	66.32^{000}
	Difference	-1246	-18.27	-3.46
LSD	5%	52	1.57	0.16
	1%	69	2.09	0.21
	0.1%	89	2.72	0.27

The yields obtained in the three years was influenced by environmental conditions of late, so in 2009, considered the least dry, yields obtained are significantly negative with a distinct difference of -72 kg/ha, in 2011, considered very dry, have obtained very significantly negative differences, with a difference of -1246 kg/ha, and 2010, considered to excessively wet obtained higher yields with 1317 kg/ha, the difference being very significant positive compared with control, average years (Table 11). The weight of 1000 grains (TKW) was influenced by the climatic conditions in 2009 and 2010, obtaining very significant positive differences compared to the control, and in 2011 the difference being very significant negative towards the average years. Hectolitre weight was higher in 2009, but lower in the 2010 and 2011.

4. Conclusions

The yields obtained in unconventional tillage system (chisel) are close to those of the classic system, maize requiring a soil movement on a greater depth than other plants grown in minimal systems. Additional fertilization bring a plant production increase, are necessary especially in the years abnormal climatic point of view. Climatic conditions have a large influence over crop, yields obtained are dependent on the amount of rainfall in the period of vegetation. We conclude that conservative tillage system by reserve of inoculum that remains on the soil surface in favorable climatic conditions result in a more accentuated disease both strains of maize and the cobs.

Soil tillage in conservative system increase the percentage of maize with *Fusarium* spp. diseases.

In conclusion, the most important pests of maize crop, who were followed both in conventional system, as well as in minimal tillage system, recorded an abundance, but also a slightly higher attac frequency (%) in system with minimal tillage of the soil (with chisel), in the years included in the study.

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