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THE INFLUENCE OF TILLAGE SYSTEM ON WEEDS AND MAIZE YIELDS, IN DIFFERENT PEDOCLIMATIC CONDITIONS OF TRANSYLVANIAN PLAIN, DURING 2007-2018

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ABSTRACT

Among the technological factors that contribute to the yield of maize, the fight weeds is a mandatory requirement. In 2007, a factorial yield test was performed at the Agricultural Research and Development Station (ARDS) Turda, where was studied the influence of the two systems, the classic (CS) and the minimum tillage one (MT) on the weeds and the yield maize, for a period of 12 years. Generally the total number of weeds in MT was higher (343 pcs. m^{-2}) than CS (324 pcs.m^{-}2), because, without soil inversion, weed seeds remained in the soil surface layer where climate conditions stimulated weed germination. The cultivation of maize in minimum tillage system could be recommended as a viable alternative to the classical system in the hilly area from Transylvania, this recommendation is also based on the rather small quantitative differences (133 kg ha^{-1}) between the two tillage systems.

Keywords: maize, tillage methods, weeds, climatic conditions, yield.

INTRODUCTION

The maize is one of the most cultivated cereals in the world (FAOSTAT, 2016). The popularity of this crop is due to the high yield per unit area, low requirements for soil quality and for its position in the crop rotation. Maize grains are important because of the high nutritive value, in the feeding of pigs and poultry, as well as being a highly demanded feedstock for food purposes, such as the yield of maize flour, grits and starch (Holka et al., 2017).

The first experiments with the minimum tillage system were made in Romania for maize crop, in 1962, at Fundulea and later in other research stations such as: Lovrin, Oradea etc., the first results being published in 1966 (Guş et al., 2003). The results obtained by Pintilie (1979) on the leached Chernozem from Fundulea and on the brown-red soil from Simnic - Dolj showed that on the lands that were not plowed, even if the herbicides were applied, the weed number increased and the maize yield dropped to a quarter (840 kg/ha). Both Cardina et al. (1991) and Feldman et al. (1997), showed that the density and contents of the weed seed reserve in the soil varied according to the soil tillage system.

The diversity of the seed reserve increased from the moldboard ploughing, to disk, chisel and no tillage, which had the biggest seed reserve (Rusu et al., 2013). In order to fight weeds one must state the importance of the methods and agro-technical measures that accompany the technology of the cultivating, which act upon weeds restrictively, indirectly, reducing the risk of infestation with species existing in the respective land (Berca, 2011; Rusu et al., 2014) and, in certain cases, decreasing the risk of infestation with certain weed species (crop rotation, the use of fertilizers and amendments, rational sowing, adequate phytosanitary methods).

The crop rotation is an important part of the integrated weed control strategy and continue to remain one of the measures with high efficiency in fighting weeds (Anderson, 2006; Cociu, 2011; Simić et al., 2016). By applying specific agro-technical measures to each plant from the crop rotation, the growth and the breeding of certain weed species is diminished, the rotations of crops facilitating the rotation of herbicides having the ability to

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control different annual and perennial weed species (Simić et al., 2016).

In the last few years there has been an alarming increase in droughts, which is why we must preserve soil water, and the choosing the range of machine and technology is the most important issue (Rusu et al., 2009; Cociu and Cizmaş, 2013). By protecting the soil with vegetable debris (mulch), we avoid losing water through evaporation and also suffocating the weeds emerged or under emerging (Cheţan et al., 2016).

The maize is very much studied in regards crop requirements in minimum soil tillage system, choosing the type of hybrid for this system has been a constant preoccupation for breeders (Lăzureanu et al., 1997). For the maize hybrids destined to the crop in minimum soil tillage system, the following features are taken into account even more: the capacity to germinate at low temperatures, early vigor and a vegetation period shorter than of the hybrids traditionally cultivated in the area, resistance to disease and pests specific to the mulch system.

Starting from these considerations, in the year 2007 a factorial trial was performed at the Agricultural Research and Development Station (ARDS) Turda, having as objective to monitor the evolution of maize yield, under the influence of the tillage system, weeds control, fertilization, crops rotation and climate conditions.

MATERIAL AND METHODS

The biological material chosen for this trial was represented by the maize hybrid Turda Star. The experimental field is located at 23°47′ longitude; 46°35′ latitude; 427 m altitude, in Western part of Transylvanian Plain.

Soil and Climatic Description

The experience was based on a Phaeozem soil (SRTS, 2012), with clay-clay texture with good hydrophobic properties, 59% porosity on the surface and 47% in depth, high water retention capacity of 32% and Co 18%; with agrochemical indices (MESP, 1987): pH 7.00; humus 2.94%; total nitrogen 0.162%; phosphorus 9 ppm; potassium 140 ppm (values determined on the depth of 0-40 cm in soil). The terrain is represented by a hilly orographic frame, in a preponderant proportion of 71%, with different inclinations, in an advanced erosion stage.

Of the 12 years of the thermal regime, six were warm, four slightly warm and only two normal, while in four years rains were excessive, two years very rainy, five years normal and just only one dry year (2011 with an annual rainfall of 433 mm). The average annual values related compared to the multiannual average (62 years) with temperature of 9.1°C and precipitation of 531 mm. During this period the rainiest year was recorded in 2016 with 816.8 mm, the deviation being +303.2 mm, but with an uneven distribution. The rainfall regime has increased in the Turda area in the last years, during the experimentation period, the highest rainfall being in 2010, 2014 and 2016. The average value of 609.8 mm for the last 12 years, is maintained in the area. The highest rainfall values are obtained in the summer months, especially in June, which is the rainy month of the year. Specific for those 12 years was the uneven distribution of precipitation (2009, 2011, 2012, 2013), prolonged drought followed by torrential rains, which, although had large quantities of water, often did not manage to restore the water reserve in the soil and the drought dominated the whole period.

The weather conditions during the maize growing season on the 12 year (measured at Meteorological Station Turda 23°47′ longitude; 46°35′ latitude; 427 m altitude) can be seen in Tables 1 and 2.

In all 12 years, the sum of precipitation (mm) during the crop vegetation period (May-August) was lower than the 62 years average (286.3 mm), especially in 2009 (235.4 mm), 2012 (237 mm), 2013 (247.1 mm) and 2017 (242.3 mm). According to that, the grain yield of maize was the lowest in these years, except the year 2017, when a high yield was registered due to rainfall recorded in July (110.2 mm). Comparative with the multiannual average (18.1ºC), the thermic regime during the May-August period in all experimental years has increased, especially in July and August (oven 20ºC) temperature ranging between 19-24ºC in July and 19.6-22.3ºC in August. The highest average temperature recorded in this period corresponds to 2012 with 20.9ºC and 2018 with 20.2ºC. For the conditions in Romania, J. Humlum (quoted by Salontai, 1982) established that grain yield per hectare exceeds the average when rainfall exceeds 40 mm in May, 60 mm in June, 60 mm in July and below 80 mm in August. For maize, summer rainfall has a decisive influence on the yield, and even the distribution is more important than the total amount of rainfall. Maize growth takes place in good conditions when the average temperatures do not fall below 13ºC in May and below 18ºC in July and August (Ion, 2010).

Table 1. The thermic regime 2007-2018

Years/ months	Temperature - monthly average (°C) during maize growing season				Average
	May	June	July	August	
2007	17.0	20.3	22.0	20.1	19.9
2008	15.0	19.4	19.5	21.0	18.7
2009	16.2	18.7	21.0	20.7	19.2
2010	15.4	18.9	20.7	21.0	19.0
2011	15.6	19.2	20.1	20.8	18.9
2012	16.2	21.0	24.0	22.3	20.9
2013	16.8	19.4	20.9	22.1	19.8
2014	15.1	18.5	20.4	19.9	18.5
2015	15.8	19.4	22.3	21.9	19.9
2016	14.3	19.8	20.5	19.6	18.6
2017	15.7	20.7	20.3	22.3	19.8
2018	18.7	19.4	20.4	22.3	20.2
Av. 12 years	16.0	19.6	21.0	21.2	19.4
Av. 62 years	15.1	17.9	19.8	19.4	18.1

Table 2. The rainfall regime 2007-2018

Years/ months	Precipitations - monthly sum (mm) during maize growing season				Sum
	May	June	July	August	
2007	103.8	77.1	54.4	118.1	353.4
2008	89.0	136.8	125.2	9.0	360.0
2009	31.4	113.4	52.5	38.1	235.4
2010	87.6	172.6	121.0	49.2	430.4
2011	41.4	116.8	130.4	12.8	301.4
2012	89.2	67.4	52.4	28.0	237.0
2013	79.3	86.2	37.6	44.0	247.1
2014	66.2	48.4	144.4	83.8	342.8
2015	66.0	115.7	52.2	72.2	306.1
2016	90.4	123.2	124.9	91.0	429.5
2017	65.4	30.6	110.2	36.1	242.3
2018	56.8	98.3	85.7	38.2	279.0
Av. 12 years	72.2	98.9	90.9	51.7	313.7
Av. 62 years	68.3	84.2	77.8	56.0	286.3

Field management

The crop rotation was based on the fact that the main crops grown on the farms in this area, are maize, wheat and soybean.

The preceding crop was winter wheat, the residues of the preceding crops were chopped and spread on the soil surface (in the unconventional system). The three years rotation was maize-soybean-winter wheat, winter wheat being seeded in the classical and "no-tillage" system, whereas soybean and maize in the classical and "minimum tillage" system. The overall surface of the trial was 0,35 ha, and the design was a split plot with three replications (blocks), each block being divided into three columns with a surface of 1152 m^2, corresponding to each crop of the rotation.

The experimental factors were the following: factor a - the agricultural year with 12 graduations: 2007; 2008; 2009; 2010; 2011; 2012; 2013; 2014; 2015; 2016; 2017; 2018; factor b - the soil tillage system with two graduations: the classical tillage (CS) and minimum tillage (MT); factor c - the mineral fertilization with two graduation: $N_{40}P_{40}$ kg a.c./ha at same time with sowing; $N_{40}P_{40}$ kg a.c./ha at same with sowing + N_{40} kg a.c./ha on vegetation at the stage BBCH 15-16 of maize (five to six leaves).

In the MT the processing of the soil was made in autumn with chisel at 30 cm depth and, in spring before sowing, the germinating bed was prepared with the rotary harrow. In the CS the autumn ploughing was made at same depth (30 cm) followed by preparing the germinating bed in spring with rotary harrow. The maize was planted with a population of 65,000 plants ha^{-1} using a combined planter for seeding and fertilizing of the type GASPARDO MT-6 with six rows and 70 cm row spacing, and 22.5 cm distance between seed/row, the seed being treated with active ingredient *fludioxonil* 25 g/l + *mefenoxam* 10 g/l (trade name Maxim XL 035FS in dose 1.0 l/to seeds). No diseases or pests controls were utilized. The pre-emergence treatment was made with herbicides mixture based on 240 g/ha *isoxaflutol* 240 g/l (trade name Merlin Flexx, 0.4 l/ha) and *ciprosulfamida* (safener) + 960 g/l *S-metolachlor* (trade name Tender, 1.5 l/ha) and post-emergence with herbicide based on *fluroxipir* 250 g/l (trade name Cerlit, 1.0 l/ha) + *nicosulfuron* 40 g/l (trade name Astral, 1.5 l/ha). For the soybean and the winter wheat included in the rotation specific herbicides to control weeds were used.

Sampling and methods

The degree of weeds infestation in the crop and the weeds spectrum present was evaluated with the metric frame method: weed species were identified and their individuals were counted before the application of the foliar herbicide (the maize in three-five leaves), leaving them in the maize crop and at 10 days before maize harvesting, weeds being collected from 1 m^{-2} of each plots (three samples were averaged).

The number of weed present and the species were determined, after which they were oven dried and was calculated their weight. The yield of maize crop was determined by weighing the grain harvest of experimental plots (after eliminating the margins) and recalculating the grain yield at 14% humidity.

Statistical analysis

The experimental data were processed by ANOVA and calculating the Least Significant Differences - LSD (5%, 1%, and 0.1%) (ANOVA, 2015).

RESULTS AND DISCUSSION

Crop weeds appeared even from the beginning of the vegetation period, annual and perennial dicotyledonous species infesting the land early, the annual and perennial monocotyledonous species appearing later in the field. Before post-emerging treatment with herbicides we identified 20 weed species, in the reporting period 2007-2018 of which: 17 species were annual (DA) and perennial dicots (DP): *Xanthium strumarium, Chenopodium album, Convolvulus arvensis, Polygonum convolvulus, Polygonum aviculare, Amaranthus retroflexus, Hibiscus trionum, Capsella bursa-pastoris, Sonchus oleraceus, Rubus caesius, Arctium lappa, Cirsium arvense, Cardaria draba, Viola arvensis, Raphanus raphanistrum, Rorippa austriaca, Matricaria inodora*, respectively 3 species annual (MA) and perennial monocots (MP): *Agropyron repens, Setaria glauca* and *Echinochloa cruss-galli*. The results of weed population in the maize was specific to the crop, the species from maize being typically: *Xanthium strumarium, Amaranthus retroflexus, Hibiscus trionum, Convolvulus arvensis, Rubus caesius, Cirsium arvense, Setaria glauca* and *Echinochloa cruss-galli.* With more than 20 pieces m^{-2} they are among the most troublesome weeds (Table 3).

Table 3. Weed infestation of the maize crop before post-emerging treatment (pcs. m^{-2}), during 2007-2018

No.	Weeds spectrum	Weed (pcs. m^{-2}), 2007-2018	
		System	
		CS	MT
1	*Xanthium strumarium*	38	39
2	*Chenopodium album*	17	19
3	*Convolvulus arvensis*	16	25
4	*Polygonum convolvulus*	17	17
5	*Polygonum aviculare*	2	6
6	*Amaranthus retroflexus*	18	21
7	*Agropyron repens*	23	37
8	*Hibiscus trionum*	30	26
9	*Capsella bursa-pastoris*	10	10
10	*Setaria glauca*	26	22
11	*Sonchus oleraceus*	13	16
12	*Rubus caesius*	14	23
13	*Arctium lappa*	1	3
14	*Cirsium arvense*	19	25
15	*Cardaria draba*	6	7
16	*Viola tricolor*	15	16
17	*Echinochloa cruss- galli*	22	20
18	*Raphanus raphanistrum*	15	15
19	*Rorippa austriaca*	9	10
20	*Matricaria inodora*	7	8

The participation of weed species to the degree of weed infestation in the maize crop is presented in Table 4.

The strongest weed infestation before the application of the foliar herbicide are given by the high percentage by DA weeds, 191 pcs.m^{-2} (29%) in CS and 182 pcs.m^{-2} (27%) in MT. The DP weeds were mostly present in

MT 89 pcs.m^{-2} (13%) compared to CS 64 pcs.m^{-2} (10%). The MT system determined an MA 35 pcs.m^{-2} (5%) compared to CS where weeds were 46 pcs.m^{-2} (7%). The MP weeds recorded a lower value in CS with 23 pcs.m^{-2} (3%) and a higher value in the MT, 37 pcs. m^{-2} (6%). Generally the total number of weeds in MT was higher (343 pcs. m^{-2}) than CS (324 pcs.m^{-}2), because, without soil inversion, weed seeds remained in the soil surface layer where climate conditions stimulated weed germination. The weeds structure present in the maize culture in the reporting period 2007-2018 was as following: dicots 79% and monocots 21%.

The investigation for weed control in maize during 2003-2005 presented by Bogdan et al. (2007), at the beginning of the maize vegetation was composed mainly of annual grasses with 48-55.7% participation, followed, in the frequency and risk order for maize plants, by the perennial dicots and annual dicots. The number of identified species ranged between 17 and 21, of which, problem weeds belonged to species: *Echinochloa crus-galli; Setaria glauca, Chenopodium album; Amaranthus retroflexus; Cirsium arvense; Convolvulus arvensis* and *Sonchus arvensis.*

The weed species identified in the maize crop before harvesting were DA in MT 33 pcs.m^{-2} (15%) compared to CS 30 pcs.m^{-2} (14%). The MT system determined an MA 24 pcs.m^{-2} (11%) compared to CS where weeds were 32 pcs.m^{-2} (14%). The MP weeds recorded a lower value in CS with 16 pcs.m^{-2} (7%) and a higher value in the MT 35 pcs. m^{-2} (16%). The total number of weeds DA, DP and MP in MT was higher than in CS, but we can observe a decrease in the number of MA. The weed structure present in maize crop in the reporting period 2007-2018 before the maize harvesting was: MT dicots 30% and monocots 27%; CS dicots 22% and monocots 30%. The main benefit of CS was the high decline of perennial weeds in comparison to MT (Table 3).

Table 4. The average weed density of different groups of weeds in the tillage systems during 2007–2018 (pcs. m^{-2}; %)

Degree of weeds/tillage system		Weeds structure							
		DA		DP		MA		MP	
		pcs.m^{-2}	%	pcs.m^{-2}	%	pcs.m^{-2}	%	pcs.m^{-2}	%
Before application of the foliar herbicide	CS	191	29	64	10	46	7	23	3
	MT	182	27	89	13	35	3	37	6
Differences CS-MT ± pcs.m^{-2}; %		+9	+2	-25	-3	+11	+4	-14	-3
Before maize harvesting	CS	30	14	18	8	32	14	16	7
	MT	33	15	34	15	24	11	35	16
Differences CS-MT ± pcs.m^{-2}		-3	-1	-16	-7	+8	+3	-19	-9

The weed dry biomass determined in the CS before maize cropping (2007-2018) had values of 57.15 t ha^{-1} with a composition of 33.95% annual monocotyledonous species (19.4 t ha^{-1}), 47.76% annual dicotyledonous species (27.3 t ha^{-1}), perennial monocotyledonous species 0.97% (0.55 t ha^{-1}) and 17.32% perennial dicotyledonous species (9.9 t ha^{-1}). The largest weed biomass accumulation noted in the MT variant, was 67.65 t ha^{-1} with 14% annual monocotyledonous species 14 t ha^{-1}), 44.80% annual dicotyledonous species (30.3 t ha^{-1}), perennial monocotyledonous species 3.62% (2.45 t ha^{-1}) and 30.90% perennial dicotyledonous species (20.9 t ha^{-1}). The potential of soil for weed invasion with large vegetative mass species, as well as climatic conditions of this area, favoured the weed invasion, the dicotyledonous species especially, in both tillage systems.

The main benefit of the CS was a highly important decline of perennial weeds (Table 5).

Table 5. The weed dry biomass (g m^{-2}), under the different soil tillage (2007-2018)

System/year		Botanical groups											
		DA			DP			MA			MP		
		pcs.$^{m-2}$	g m^{-2}	t ha^{-1}	pcs.$^{m-2}$	g m^{-2}	t ha^{-1}	pcs.$^{m-2}$	g m^{-2}	t ha^{-1}	pcs.$^{m-2}$	g m^{-2}	t ha^{-1}
CS	2007	3	310.2	3.1	2	86.7	0.9	2	121.1	1.2	2	5.2	0.05
	2008	2	129.7	1.3	1	42.3	0.4	1	41.3	0.4	2	6.9	0.07
	2009	2	192.3	1.9	1	19.1	0.2	3	165.2	1.7	1	3.4	0.03
	2010	4	357.5	3.6	2	87.8	0.9	2	118.7	1.2	1	3.8	0.04
	2011	3	394.1	3.9	2	101.4	1.0	2	102.1	1.0	1	4.1	0.04
	2012	2	116.6	1.2	1	32.5	0.3	3	162.3	1.6	1	3.1	0.03
	2013	2	127.2	1.3	1	41.4	0.4	3	221.2	2.2	2	5.9	0.06
	2014	1	94.4	0.9	2	94.7	0.9	2	189.5	1.9	2	6.7	0.07
	2015	2	156.3	1.6	2	114.2	1.1	3	175.7	1.8	1	4.5	0.05
	2016	2	137.9	1.4	1	93.5	0.9	4	225.5	2.3	1	3.9	0.04
	2017	3	288.4	2.9	1	104.3	1.0	4	217.9	2.2	1	3.4	0.03
	2018	4	421.7	4.2	2	189.0	1.9	3	185.7	1.9	1	4.3	0.04
Total a_1		**30**	**2726.3**	**27.3**	**18**	**1023.6**	**9.9**	**32**	**1918.8**	**19.4**	**16**	**55.2**	**0.55**
MT	2007	5	487.1	4.9	3	142.3	1.4	3	142.3	1.4	3	7.8	0.08
	2008	4	422.5	4.2	2	88.5	0.9	2	117.8	1.2	3	11.9	0.2
	2009	3	357.6	3.6	2	101.4	1.0	2	125.3	1.3	4	14.5	0.2
	2010	5	435.0	4.4	3	156.9	1.6	1	49.1	0.5	3	13.4	0.3
	2011	4	418.7	4.2	4	224.3	2.2	1	47.3	0.5	3	16.7	0.2
	2012	2	121.3	1.2	2	159.8	1.6	3	125.8	1.3	4	18.9	0.2
	2013	3	254.2	2.5	3	156.3	1.6	4	215.5	2.2	3	17.6	0.8
	2014	2	169.3	1.7	4	221.2	2.2	2	176.4	1.8	2	6.1	0.06
	2015	1	98.7	0.9	2	118.5	1.2	2	165.6	1.7	2	7.1	0.07
	2016	1	101.2	1.0	2	100.4	1.0	1	38.9	0.4	3	17.2	0.2
	2017	1	91.1	0.9	3	227.8	2.3	2	117.5	1.2	3	13.7	0.1
	2018	1	83.7	0.8	4	388.4	3.9	1	51.1	0.5	2	4.1	0.04
Total a_2		**33**	**3040.4**	**30.3**	**34**	**2085.8**	**20.9**	**24**	**1373.1**	**14**	**35**	**142.7**	**2.45**

The influence of year on the maize yield

It is known that the yielding potential is a character influenced by a relatively large share of external factors, such as: climatic conditions (amount of precipitation and their distribution, temperature etc.), pedological conditions (soil fertility, humidity, texture, etc.) and the agrotechnical conditions (the preparation of the soil, the type and doses of fertilizers, the density and the sowing time, methods to control weeds, diseases and pests, etc.). In addition to these external factors, the production potential is closely linked to the genotype, a factor that, as Săulescu (1980) asserted, contributes to the yield increase, without requiring additional energy consumption, but leading to a significant increase in the efficiency of energy investments. The quantitative variation of the yields from the 12 years of experimentation is very eloquent in terms of the influence of the environmental factors in the formation of maize production, the minimum and maximum thresholds being 4102 kg ha^{-1} (2011), respectively 7625 kg ha^{-1} (2016), the amplitude of variation being quite high, namely 3523 kg ha^{-1}. Compared to the control, the highest positive deviations were registered in the last experimental years, the differences being significantly positive, over 1000 kg ha^{-1}, the record being reached in 2016, when the difference was 1644 kg ha^{-1} (Table 6).

By corroborating the data, another important aspect can be noticed, namely that in 2016, when the record yield of the 12 experimental years was reached, the average degree of weeds infestation in the two soil tillage systems registered the lowest values (below 1 t ha^{-1}). The upward trend in the average maize yields of the last five experimental years, when the differences were between 610 and 1644 kg ha^{-1}, was due in particular to the favourable climatic conditions, which also favoured to some extent the expression of the yielding potential of the Turda Star hybrid, and of maize in general.

Table 6. The influence of the years on the average maize yield in the two systems and fertilization levels, 2007-2018, at ARDS Turda

Year	Yield (kg ha^{-1})	Difference
Average	5981	0^{Ct}
2007	5701	-280^{000}
2008	5538	-443^{000}
2009	4172	-1809^{000}
2010	6133	152^{***}
2011	4102	-1879^{000}
2012	5253	-728^{000}
2013	5416	-565^{000}
2014	6591	610^{***}
2015	6825	844^{***}
2016	7625	1644^{***}
2017	7233	1252^{***}
2018	7184	1203^{***}
LSD (p 5%) = 24; LSD (p 1%) = 33; LSD (p 0.1%) = 48; Ct-control		

The influence of the tillage system on the maize yield.

The MT processing system had a very negative influence on the maize yield compared to CS, considered as control. However, given the positive effects of the MT system on the physicochemical properties of the soil and the economic efficiency (Cheţan et al., 2016), the cultivation of maize in this system could be recommended as a viable alternative to the classical system in the hilly area from Transylvania. This recommendation is also based on the rather small differences (133 kg ha^{-1}) between the two tillage systems (Table 7).

Table 7. The influence of the tillage system on the maize yield during 2007-2018, at ARDS Turda

Tillage system	Yield (kg ha^{-1})	Difference
CS	6048	0^{Ct}
MT	5914	-133^{000}
LSD (p 5%) =16; LSD (p 1%) =23; LSD (p 0.1%) = 32; Ct- control		

On the contrary, the results of the study conducted by Cociu et al. (2017) at Fundulea, indicated that the 8-year average yield of maize was significantly lower in the conditions of classic tillage (8.82 t ha^{-1}) than in minim tillage (9.05 t ha^{-1}). These contradictory results could be due to several factors, such as the pedo-climatic conditions, type of hybrid, technological factors, etc. We can also note that, even in the Fundulea experiment the average difference between the two systems was only 230 kg ha^{-1}.

The influence of fertilization on the maize yield

As compared to the yield obtained in the variant with basic fertilization (5885 kg ha^{-1}), the yield increase in the case of the additional fertilization was 292 kg ha^{-1}. The additional (localized) application of nitrogen in the five-six leaf stage, the intensive absorption phase of fertilizers and the explosive growth of plants showed a distinctly significant positive influence on the yield increase (Table 8).

Table 8. The influence of fertilization on the maize yield during 2007-2018, at ARDS Turda

Fertilization level	Yield (kg ha^{-1})	Difference
$N_{40}P_{40}$	5885	0^{Ct}
$N_{40}P_{40} + N_{40}$	6177	191^{***}
LSD (p 5%) = 22; LSD (p 1%) = 37; LSD (p 0.1%) = 42; Ct-control		

Figure 1 shows the yield differences between the MT system and the CS in the 12 years of experimentation. The highest production gaps between the two technological systems were registered in 2010 for both levels of fertilization, differences reaching about 1000 kg ha^{-1} in favour of the classic system.

The rainfall regime of the previous year mentioned (from May-August) was the highest of the 12 years. The yield differences in the other years were much smaller and did not exceed the value of 259 kg ha^{-1} in 2012. It can also be noted that in the last experimental years, starting with 2015, the yield differences between the two systems, on both levels of fertilization, became positive in favour of the MT system (exception being the year 2017).

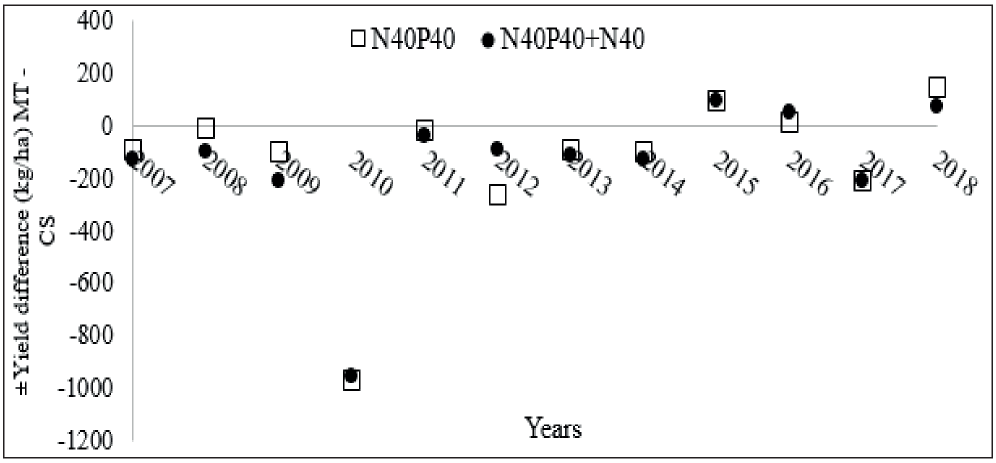

Figure 1. The difference between yields in the CS and the MT system and at different levels of fertilization, for the Turda Star hybrid, during 12 years (2007-2018)

CONCLUSIONS

The number and mass of DA weeds present in the maize crop was larger in the MT during the first eight experimental years but, starting with 2015, the weed number decreased, compared to the CS where the weeds were still present over the entire period, in quite large amounts.

The main benefit of CS was the high decline of perennial weeds in comparison to MT.

The MT led to a reduction in the annual monocotyledonous weeds.

In the Transylvanian Plain, the level of maize yields was tightly connected to the tillage system and the climatic conditions of the cultivation year.

Based on the results obtained and for better soil protection we can recommend the use of the technology with minimal works for the maize cultivation in the hilly area of Transylvania.

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