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THE INFLUENCE OF THE TILLAGE SYSTEM ON THE WEEDING DEGREE AND MAIZE YIELD IN TRANSYLVANIAN PLAIN

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Abstract: The research of alternative variants to the conventional tillage system (characterized by plowing with furrow turning) pursued the development and promotion of technologies adapted to the specific conditions of different agricultural areas, especially regarding soil type, climatic conditions, land topography and equipment available. The failure of the extension of many alternative tillage practices has been linked to weeding, cultural deficiencies and lower yields. The paper presents the results of research regarding the influence of the tillage system, fertilization and chemical treatments, the degree of weeding of the crop and the yield of maize during 2018–2021, under the conditions of the Turda Agricultural Research and Development Station (ARDS) Turda, located in the Transylvanian Plain.
Keywords: climate, tillage system, weeds, maize, yields

1. INTRODUCTION

Weeds cause crop problems due to their ability to reproduce and tolerance to many herbicides, competing strongly with cultivated plants for water, nutrients and light (*Din et al., 2011; Popescu, 2007; Bhatt and Singh, 2007; Chețan and Chețan, 2020*). By expanding new unconventional farming systems, specific to sustainable agriculture and with a strong infestation of perennial weeds, it is more difficult to combat them (*Feldman et al., 1997; Clay et al., 2005; Rusu et al., 2013; Maqsood et al., 2020*). In general, the seeds of mature weeds shake and remain on the surface of the soil or in the first cm of soil (*Chauhan and Johnson, 2008; Cousens and Moss, 1990*) infesting the plant that follows in rotation (*Douglas et al., 2001; Chețan et al, 2022*).

The remaining vegetable residues from crop harvesting and evenly spread on the soil surface (mulch) are also an agrotechnical method of weed suppression, the weeds being devoid of light are inactive (*Berca, 2004*). Numerous studies and research from the literature mention that in the rotations in which the autumn cereals predominating, some species of weeds can multiply greatly, because they are well adapted ontogenetically to these crops (*Guş et al, 2003; Hussain et al., 2022; Chețan et al., 2016*).

Maize is part of the group of the most important agricultural crops, both in Romania and worldwide (*Petcu et al., 2015*). This importance is mainly due to the large areas on which it is grown, the yield/ha and the diversified use (*Haş, 2004*). In the form of grains or silo, it is a high caloric source in animal feed, containing a higher percentage of fat and a lower protein content compared to other cereals (*Huma et al., 2019; FAOSTAT, 2016*). It is the main source of food in people's diets, especially in low–developed or developing countries. Also, maize is used in the form of flakes, flour, popcorn etc. It is also an important source of starch. To this wide range of use is added the use of corn in the production of bioethanol and biogas.

Knowledge of scientific developments in agriculture allows the choice of the latest technologies to meet the requirements of producers and consumers alike (*Vlăduț et al., 2012; Stefan, 2004; Gy et al., 2018; Riley et al., 2005*). SCDA Turda has a rich and well–defined portfolio of maize hybrids, so as to cover farmers' demands, taking into account the pedo–climatic zone where they have their land. Among the newer maize hybrids created in Turda is the "Turda 332" hybrid from FAO group 380 (*Haş et al., 2014*).

The paper presents the results of the research carried out under the conditions of Agricultural Research and Development Station (A.R.D.S.) Turda, located in the hilly area of the Transylvanian Plain. It followed the dynamics of weeding and the maize yield, under the influence of two variants of soil work, treatments and climatic conditions during 2018–2021.

2. MATERIAL AND METHOD

The experiment was located at A.R.D.S. Turda and was set up on a Chernozem soil, with a neutral pH, medium content in humus and good supply of nitrogen, phosphorus and potassium determinate on 0–30 cm depth (O.S.P.A. Cluj–Napoca). The experiment was contained in a three–year rotating soya–wheat–corn. The biological material was represented by the maize hybrid "Turda 332".

Experimental factors:

- A – Tillage system: a_1 conventional (CS); a_2–unconventional (NT);
- B – Weed control treatments, application: b_1–preemergence with 0,4 L/ha product based on isoxaflutol 240 g/L and ciprofulfamide (safener) 240 g/L) + 1,4 L/ha based on dimethenamid–P (optically active) 720

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g/L); b_2– preemergence with 0,4 L/ha product based on isoxaflutol 240 g/L and ciprofulfamide (safener) 240 g/L) + 1,4 L/ha based on dimethenamid–P (optically active) 720 g/L) + postemergence in 3–5–leaf maize phenophase with 1,0 l/ha fluroxypir–based product 250 g/l + 1,5 l/ha based on 40 g/l nicosulfuron;

- C – Year (climatic conditions): c_1 2018; c_2 2019; c_3 2020; c_4 2021.

Except for the NT variant, immediately after the harvest of the crop (wheat in the present case), in the CS variant the processing of the land was carried out in the autumn by the plow at 28 cm depth, then in the spring the preparation of the seedbed by a single pass with the rotating harrow.

The sowing was carried out with the Gaspardo MT–6 sowing machine (Figure 1) at 65.000 plants/ha density, the maize seed being treated with 1,0 L/t fungicide based on 25 g/L fludioxonil 9,7 g/lmetalaxyl–M (mefenoxam).

Fertilization was achieved with 350 kg/ha NPK 16:16:16 ($N_{56}P_{56}K_{56}$ s.a/ha), concomitant with sowing. It should be mentioned that by using the Gaspardo MT–6 sowing machine and high capacity tractors, maize sowing can also be done in semi–prepared field, with or without vegetable residues. The advantage of using this seed machine is the possibility of administering the mineral fertilizers it incorporates into the soil side by row of seeds and below the seed incorporation level.

The weeding degree of the culture and the spectrum of weeds present was determined visually and numerically with the metric frame of 0.25 m², on each work system before the application of treatments.

The yield of maize (grain) obtained was weighed, converted to STAS moisture (14%) and reported to 1.0 hectare.

The results obtained were statistically processed according to the method of analyzing the variant and establishing the lowest significant differences, LSD (5%, 1% and 0.1%) (ANOVA, 2015).

Figure 1 – Sowing with Gaspardo MT– 6 machine

The climatic conditions of the experimental period (January–September 2018–2021) in Turda are shown in Figure 2 and 3 (primary data source: Turda meteorological Station longitude: 23'47– latitude 46'35'– altitude 427 m).

3. RESULTS AND DISCUSSIONS

The effect of climate change is also felt locally, through changes in climatic parameters (temperature, precipitation, wind, etc.). In Turda, every year, the first months (March, April, May and mid–June) were warmer than the 60–year multiannual average, especially 2021. A decrease in temperatures can also be observed in July and August (Figure 2).

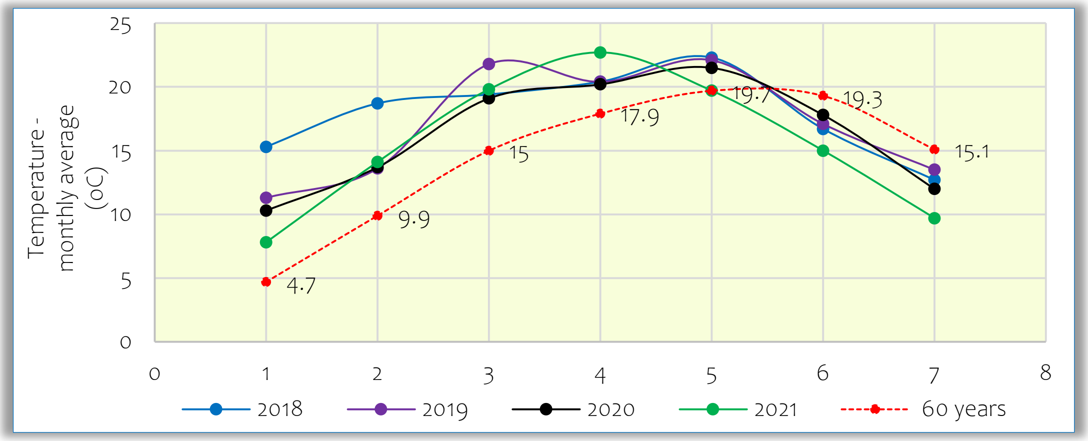

Figure 2 – The temperature regime during March–September 2018–2021 at Turda

Specific to the Turda area is the high fluctuation in the precipitation distribution (Figure 3), after periods of prolonged drought, heavy and short–lived precipitation falls, sometimes accompanied by strong winds and hail. In this case, not all the water from the precipitation seeps into the soil, part of it drains on the slopes down the valley, thus leading to the washing and transport of the fertile soil layer at the base of the hill (most of the arable land of the unit is located in the hilly areas).

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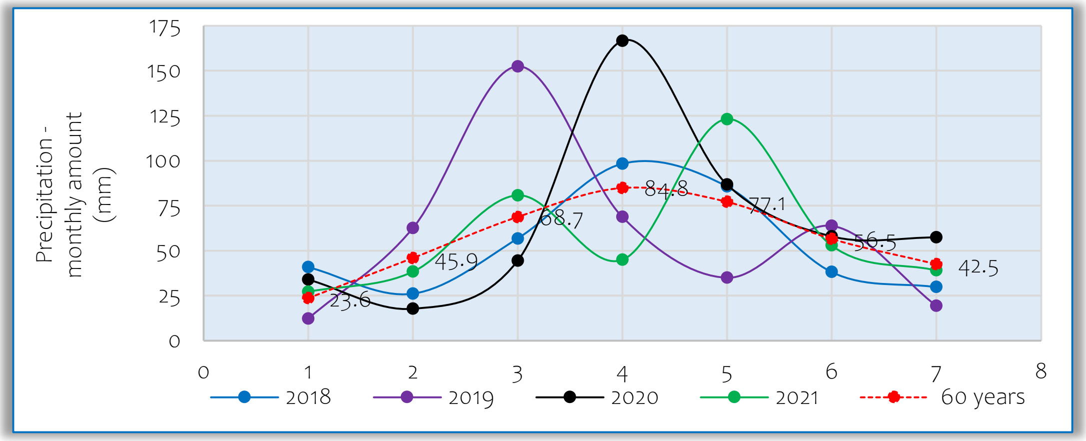

Figure 3 – The rainfall regime during March–September 2018–2021 at Turda

The reduction of the effects of atmospheric and soil drought is part of the reasons that determine the orientation toward new variants of soil works (*Chețan, 2020*).

In the spring, before the seedbed preparation, the first weeds to identify (and count) were the species *Capsella bursa–pastoris, Bifora radians, Sonchus arvensis, Cirsium arvense, Convolvulus arvensis, Sinapis arvensis, Rubus caesius, Erodium cicutarium, Galiopsis tetahit, Avena fatua* and later they came up *Amaranthus retroflexus, Chenopodium album, Datura stramonium, Hibiscus trionum, Echinochloa crus–galli, Setaria glauca, Setaria viridis, Digitaria sanguinalis, Portulaca oleraceea, Xanthium strumarium* and the perennial species *Elymus repens* (*https://gd.eppo.int/*).

In the variant where herbicidation was achieved only in post–emergence (maize in 3–5 leaves), the weeding degree of the land was higher compared to the two herbicides variant and the effectiveness of herbicides was diminished, the weeds were in a more developed vegetation phase (Figure 4). It is worth mentioning the reinfestation of the crop with the annual species *Xanthium Smurarium* (with staggered germination between April and June) in both cultivation variants (plowing, direct sowing). The fruit of this species is an ovoid scabies with two compartments each containing a seed: One grows in the first year and the second the following year, thus justifying the presence of this species in agricultural crops annually (*Ray et al., 1996; Kaul, 1971*).

It is very important to apply weed control treatment in pre–emergence, before sowing or immediately after sowing, but before maize rises. Post–emergence herbicidation may be delayed for various reasons: in low–temperature spring, the growth rate of maize is slowed and the weeds being better adapted grow rapidly invading the crop, it is not possible to enter the field due to rain during which plants and weeds advance much in vegetation and the effectiveness of herbicides on weeds is diminished, or if doses of herbicide are increased there are still additional costs and there is a phytotoxic risk to the crop. Iqbal et al. (2020) states that the critical period of crop weeding occurs from the date of maize sowing and lasts about six weeks, and excessive weeding may reduce yield by 28–100%.

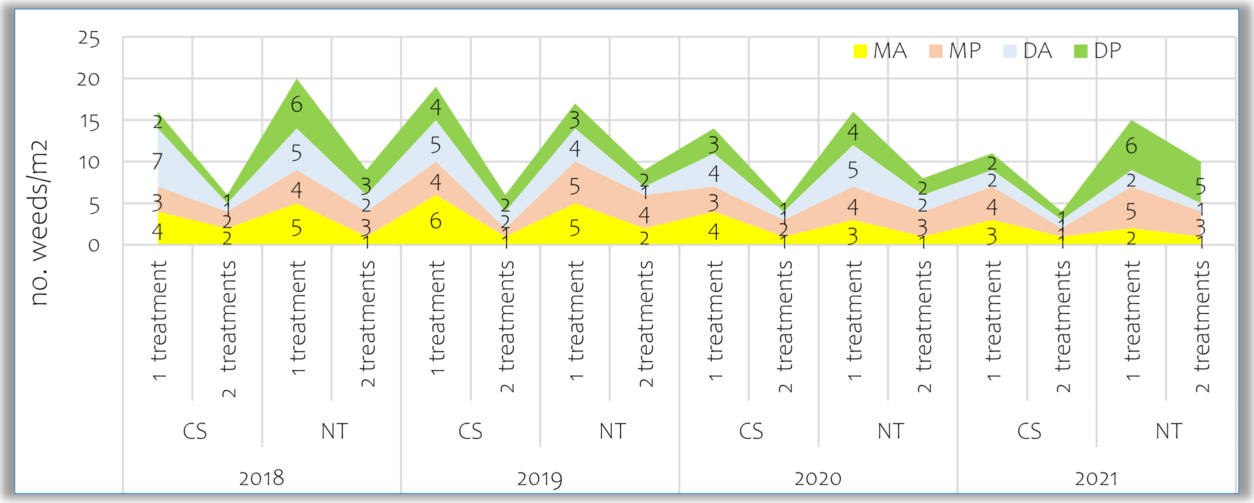

Figure 4 – The influence of experimental factors on weeding degree, Turda 2018–2021

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After four years of experimentation, the importance of plowing + two treatments in reducing the number of weeds was concluded (Figure 4). In CS the number of weeds DA, DP and MP has been reduced, but the number of weeds MA has increased. In the NT system the number of perennial weeds DP and MP increased, the mulch at the surface of the soil seems to have contributed to some extent to the decrease in the number of annual weeds.

Hussain et al. (2019) it has concluded that in the NT system only by chemical control weeds can be kept under control and is economically convenient compared to the legume variant. Other research (*Pop et al, 2011; Guş et al., 2013*) mentions that the variant with sowing directly in the stubble of the forerunner culture leads to an increase in the number of perennial weeds and that in the plowing remains one of the agro–technical methods of combating weeds.

Figure 5 – Maize harvesting maize with chopping and spreading on the ground of vegetable residues

During these four years, very rapid changes of the clime factors (temperature, rainfall), transitions from hot to cold and vice versa, as well as the abundance of torrential rains followed by long periods of drought that greatly influenced maize yield.

Of the four years of experimentation (Table 1), it seems that only 2020 was more favorable to the crop, with a very significant positive influence in the yield (6468 kg beans/ha), the difference from the control variant (average years) being 443 kg/ha.

The year 2018 was a warm year, with the rainfall regime quite consistent for the maize crop, during the vegetation period the precipitation amounted to 56.8 mm in May, 98.3 mm in June and 85.7 mm in July followed by a very dry August month (38.2 mm). These conditions have contributed to the good development of maize crop and are reflected in the 6012 kg/ha average production achieved.

In 2019, the lack of precipitation began to be felt in June, when plants have a higher water consumption, in July precipitation was also reduced (only 35 mm) and the average temperature was 22.1°C, negatively influenced the maize harvest (distinctly significant).

Maize yield was quite low in 2021 (only 5873 kg/ha) and we believe this is also due to high temperatures (22.7°C) in conjunction with the weak rainfall (45 mm) in June.

According to the literature, in achieving good harvests, maize requires optimal temperatures and precipitation for the entire vegetation period: 16–20°C/ 60–80 mm in May, 19–21°C/100–120 mm in June, 20–23°C/100–120 mm in July, 19–22°C/40–60 mm in August.

The success of the crop and the achievement of yield is conditioned by the effectiveness of the weed control method. Compared to the variant that included only a pre–emergence treatment and in which a yield of 5661 kg/ha (control variant) was achieved, the importance of the second herbicide was an essential factor in the increase of yield (6388 kg/ha), the difference compared to the control of 726 kg/ha, it is statistically secured with a very significant positive influence.

Table 1. The influence of the experimental factors on maize yield, ARDS Turda 2018–2021

The factor		Yield (kg/ha)	%	Differences	Duncan Test
A–tillage system	a_1 conventional (CS)	7100	100	0^{ct}	B
	a_2 direct sowing (NT)	4949	69.7	-2150^{000}	A
LSD 5% = 377 kg/ha; LSD 1% = 886 kg/ha; LSD 0.1% =1899 kg/ha					
B–treatments	b_1 preem	5661	100	0^{ct}	A
	b_2 preem + posteem	6388	112.8	726***	B
LSD 5% = 173 kg/ha; LSD 1% = 400 kg/ha; LSD 0.1% =1272 kg/ha					
C–Year (climatic condition)	c_0 mean	6024	100	0^{ct}	
	c_1 2018	6012	99.8	-13^{ns}	B
	c_2 2019	5745	95.4	-280^{00}	A
	c_3 2020	6468	107.4	443***	C
	c_4 2021	5873	97.5	-151^{0}	AB
LSD 5% = 149 kg/ha; LSD 1% = 209 kg/ha; LSD 0.1% = 295 kg/ha					

*** = Significant at 0.1% probability levels, positive values; $^{0, 00, 000}$ = Significant at 5%, 1% and 0.1% probability levels, negative values; ns= not significant

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4. CONCLUSIONS

The results of the research show that the maize remains a demanding plant for the soil works in our area, in the conditions of the land with a high clay content (over 40%), the tillage conventional system (CS) is preferable to the unconventional system (NT).

The maize harvest is also conditioned by the degree of crop weeding and the control measures applied, two chemical treatments (pre–emergence and post–emergence) are required because the weed infestation train occurs in a staggered manner. The unconventional system (NT) system contributes to the soil weedind with the perennial species dicotyledonous and monocotyledonous.

In this experiment, the fertilization was carried out in moderate quantities by 350 kg/ha NPK 16:16:16, on the ground that conservative agriculture also involves reducing the dosage of such fertilizers. This is the overall justification for the modest yield that were obtained in the period 2018–2021.

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