

## The Influence of the Tillage System, Hybrid and Climatic Conditions on Corn Yields in the Osmancea Area, Constanța

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### ABSTRACT

In order to achieve profitable corn crops, implementing agricultural practices that take into account soil conservation, it is first necessary to identify and use the most effective types of tillage. Secondly, this approach must be completed with attention to the selection of productive hybrids, adapted to the pedological and climatic conditions of the cultivation area.

Starting from this necessity, the objective of this paper is to present the results of the research carried out in the Constanța area in order to identify the best combination of technological factors for the cultivation of corn. The research was carried out in the years 2017-2021 within the SC Micul Agricultor SRL Company from Osmancea, Constanța County. To achieve the objectives of the research, a trifactorial experience of the 3 x 3 x 5 type was established. It was organized according to the method of subdivided plots, in three repetitions. Within it, the following factors were tested: Factor A = soil works, with graduations (a1 = plough, a2 = tiger, a3 = disk); Factor B = the hybrid, with the graduations (b1 = Mas 40 F, b2 = Dartona, b3 = P9911); Factor C = year of experimentation, with graduations (c1 = 2017 F, c2 = 2018, c3 = 2019, c4 = 2020, c5 = 2021).

The best results in terms of seed germination and yield were recorded for the variant in which the basic tillage was carried out with tiger. Using the disc for basic tillage had negative effects on the percentage of plants that emerged, but also reduced seed yield, while weed infestation was higher compared to the other types of tillage. Results show that tillage was the main factor influencing production, followed by hybrid selection. Knowledge of the effects of tillage types, combined with hybrid selection is important in developing crop management practices adapted to the condition of a particular crop area, which will ensure a balance between farmers' need to increase productivity and conserve natural soil resources.

**Keywords:** corn yield, corn hybrids, climatic conditions, minimum tillage, conventional processing, weed control.

### INTRODUCTION

Climatic changes, manifested by the increase in the average temperature, the change in the distribution and amounts of precipitation, have determined in the last decades, an increase in the areas affected by drought worldwide.

The climatic evolution of recent years in Romania presented annual and seasonal variations with large amplitudes in terms of temperature, precipitation, as well as other factors that influenced the stability of corn production in a negative way. In Romania, the most vulnerable areas to the phenomenon of extreme agricultural drought are the southern and southeastern ones, especially

Dobrogea, Bărăganul, southern Oltenia, Muntenia and Moldova, respectively, the large corn growing areas. Maize is very sensitive to drought due to the high requirements for water necessary for growth and development, but also the inability of this plant to reduce/stagnate growth under water stress conditions (Petcu and Martura, 2018).

The increase in the average annual temperature, as well as the uneven distribution of precipitation, inevitably leads to the approach of unconventional tillage options that facilitate the accumulation and preservation of water in the soil (Pintilie et al., 1979; Nagy and Ignea, 2007; Cociu, 2011; Rusu et al., 2014; Șimon et al., 2015; Popa et al., 2019; Chețan and Chețan, 2021).

Currently, thanks to scientific research, new hybrids have been created, with high production potential, new plant cultivation technologies have appeared, with the aim of achieving production at the level of the genetic potential of cultivars (varieties and hybrids), soil conservation and growth economic efficiency.

In the last decades, tillage systems have evolved a lot both globally and in Romania, conceptually but also in terms of the extension of conservative methods of tillage. Depending on the ecological characteristics of the area and the technological requirements of the cultivated plants, the soil conservation systems must be differentiated (Guş et al., 2004).

Also, in the vision of the new technological concepts for the realization of profitable productions and soil conservation, the existence of realistic forecasts is required, which take into account the technological level, the productive potential of the crops and the local pedoclimatic conditions.

Soil conservation works include very diverse procedures, from direct sowing in uncultivated soil (no-tillage, direct drill) to deep loosening without turning the furrow. Along with other factors, tillage contributes about 20% to the achievement of maize production (Khurshild et al., 2006).

The experience of the countries where conservative agriculture has expanded shows that it is of great importance for stopping soil degradation, leads to a good use of water from rainfall and irrigation, reducing climate effects, reducing expenses and last but not least, increasing productivity (Sayre and Govaerls, 2010; Kumari and Sudheer, 2016; Lalević et al., 2016).

Comparing the three tillage methods: deep ploughing, conventional works and no-tillage, it was shown that grain production was maximum with deep plowing, compared to conventional works and no-tillage (Pop and Şarpe, 1976; Marin et al., 2011; Moteva et al., 2017).

In recent years there have been increasing problems with drought, therefore it is necessary to conserve water in the soil, and the choice of the range of equipment and

technologies has an important role in obtaining profitable corn crops. Limiting the effects of the drought can also be achieved through agro-phytotechnical measures of accumulation, conservation and efficient utilization of water from precipitation.

Climatic and soil conditions play a decisive role in the optimization of practical agriculture, and taking into account different results recorded under the influence of specific research factors, a specialized, local research should be carried out to improve crop technology for a certain area. Thus, the aim of this work was to find the best types of tillage suitable and the most productive hybrids, for the pedological and climatic conditions of the Osmancea area, Constanţa County.

## MATERIAL AND METHODS

The research was carried out in the years 2017-2021 at the farm SC Micul Agricultor SRL, located in Osmancea, Constanţa County. The experiment was located on a cambic chernozem from the chernisol class. The soil structure is clay, with a neutral pH (pH = 7.15), medium supplied with humus (2.90%), very well supplied with phosphorus (139.8 ppm) and well supplied with potassium (214.8 ppm).

### Experimental design

To achieve the objectives of the research, a trifactorial experience of the 3 x 3 x 5 type was established. It was organized according to the method of subdivided plots, in three repetitions. Within it, the following factors were tested: Factor A = soil works, with graduations (a1 = plough, a2 = tiger, a3 = disk); Factor B = the hybrid, with the graduations (b1 = Mas 40 F, b2 = Dartona, b3 = P9911); Factor C = year of experimentation, with graduations (c1 = 2017 F, c2 = 2018, c3 = 2019, c4 = 2020, c5 = 2021).

### Statistical analyses

The obtained data were statistically analyzed using two-way ANOVA, thus calculating the degrees of freedom and

comparing the mean values of the factors using the Fishers Least Significant Difference (LSD) test (Săulescu and Săulescu, 1967).

**Climatic data**

Osmancea, Constanța County, is located in a temperate continental area with a multiannual average temperature (over 80 years) between April and September of 17.9°C. The average temperature recorded

between April and September in 2017 was 19.6°C, 1.7°C above the multiannual average, and in the following years the average temperature values between April and September were higher than the multiannual average as follows: in 2018 and 2019 by 2.6°C, in 2020 by 1.6°C, and in 2021 by 1.5°C higher than the multiannual average value for the same period (Figure 1).

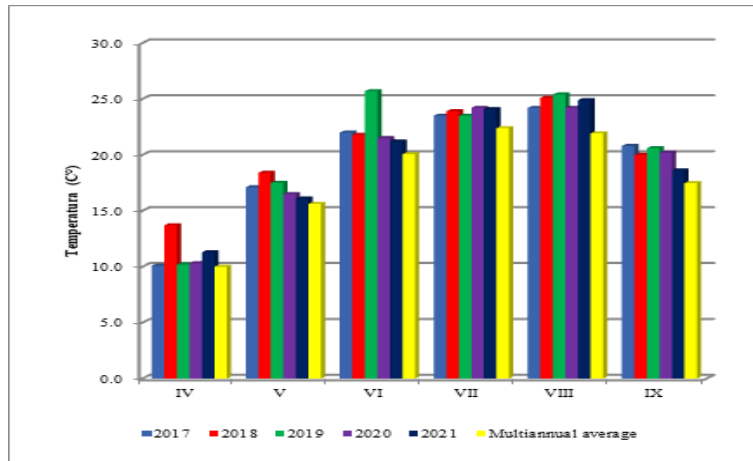


Figure 1. Evolution of average monthly temperatures

The amount of multiannual precipitation (80 years) recorded in the Osmancea area during April-September was 237.7 mm. From the 5 years of experimentation, only the years 2017 and 2018 recorded an excess of precipitation of 2.3 mm, respectively, 99.5 mm compared to the multiannual average.

In the years 2019, 2020 and 2021, there was a water deficit as follows: -35.0 mm in

2019, -115.5 mm in 2020 and -29.7 mm in 2021 (Figure 2).

Following the analysis of the climatic conditions from the years of experimentation, we can state that the general trend of temperature is increasing and the amount of precipitation is decreasing, with uneven distribution, and the amounts of monthly precipitation are the sum of several rains which as a unit value are insignificant.

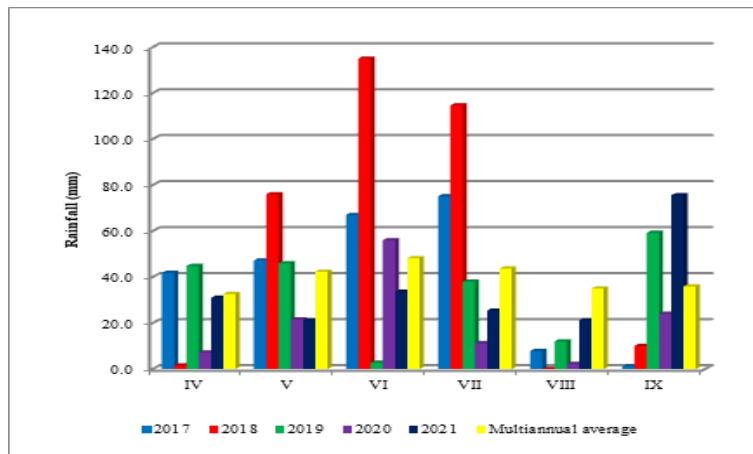


Figure 2. Evolution of rainfall in the study years

### Crop management

Regarding crop rotation, the preceding plant in the corn experiment was winter wheat (*Triticum aestivum* L.).

The soil works were carried out according to the experimental scheme with the combinations of factors. The preparation of the germinal bed was done by plowing at a depth of 5-6 cm. The corn hybrids were sown randomly, according to the experimental scheme, at a depth of approximately 5-6 cm, at a density of 63,000 germinable grains/ha. The seed was treated by the producing company with insecticide fungicides.

Weed control in the maize crop was carried out by pre-emergent application of the commercial product Wing P (212.5 g/l Dimetenamid-P and 250 g/l Pendimethalin), in a dose of 3.5 l/ha.

At the stage of 4-6 leaves to combat weeds, the corn was herbicided using the REKORD package (Callam: tritosulfuron, Dicamba and Samson Extra 6 OD: 60 g/l nicosulfuron) + Dash adjuvant.

Fertilizer doses were applied both during the preparation of the seed bed, at sowing, and during vegetation, complex fertilizers of the type 16:16:16 (250 kg/ha) were applied during the preparation of the seed bed, and ammonium nitrate (33.5% s.a.) was applied to the first mechanical grating.

**The biological material** used were semi-late hybrids from the FAO 400-450 group. The studied maize genotypes come from Maisadour, Syngenta and Pioneer.

The MAS 40F hybrid is an Elite, semi-late hybrid, from the FAO 450 group; has high production potential, tolerance to water stress; in size, it is a medium plant, it has a medium insertion of the cob, the grain is toothed; the number of rows on the cob is 16-18; the number of grains per row is 32-36; The MMB 340-360 g (<https://www.verdon.ro/seminte-cereale/samanta-porumb-mas-40f-mas-seeds-50000-boabe.html>).

The SY Dartona hybrid - comes from Syngenta and is from maturity group 400; the vegetation period is between 120-130 days; high productivity, drought and heat tolerance; High waisted; the number of rows on the cob

is 16-20; the number of grains per row is 34-38; The MMB of 350-370 g (<https://www.romagro.ro/seminte-porumb/sy-dartona-hybrid>).

The P 9911 hybrid belongs to the Pioneer company; semi-late hybrid, with high production capacity; water and heat resistant; high waist, the grain is toothed and the cob is long and compact; number of rows/stitches: 14-16; number of seeds per row: 42-44; The MMB 360-395 g (<https://www.romagro.ro/seminte-porumb/pioneer-p9911-hybrid-porumb-semi-tardiv-grupa-fao>).

### RESULTS AND DISCUSSION

In addition to ensuring optimal conditions of temperature and humidity at the time of sowing, an important role is also played by the applied agrophytotechnical measures.

The tillage system influences the percentage of emerged plants. The best percentage of emergence was achieved with the work performed with the tiger on average over the years of experimentation (94.7%), 93.8% when the tillage was plowing and 93.4% percentage of emergence with the tillage performed with the disk (Table 1).

In the years 2017 and 2019, the best percentage of emergence is registered with the tillage system by plowing (95.7%, 93.7%), a phenomenon explained by the greater capacity to store the precipitation that fell during the winter compared to the system of work with the tiger or disk, when the soil is less modified in depth.

The hybrid did not have a significant influence on the percentage of emerged plants, the differences recorded being insignificant as follows: the hybrid Mas40F recorded a percentage of sprouted plants, on average over the soil works and years of experimentation, of 94.2%, the Dartona hybrid of 93.6%, and the P9911 hybrid 94.0% (Table 1).

The percentage of emerged plants in the years of experimentation are in close correlation with the evolution of climatic factors in the respective year, the recorded differences did not show significant differences, being between 94.9% and 92.7% (Table 1).

Table 1. The percentage of emerged plants according to the experimental factors

Tillage	Hybrid	The year of experimentation					Average hybrid
		2017	2018	2019	2020	2021	
Plowing	Mas40F	95.2	94.5	95.2	92.3	92.1	93.9
	Dartona	95.2	93.5	95.2	93.2	93.5	94.1
	P9911	93.4	93.0	93.4	92.3	94.3	93.3
Average plowing		<b>95.7</b>	<b>94.6</b>	<b>93.7</b>	<b>94.6</b>	<b>92.6</b>	<b>93.8</b>
Tiger	Mas40F	98.4	94.0	98.4	95.3	95.3	96.3
	Dartona	95.2	93.0	95.2	94.4	92.3	94.0
	P9911	93.4	92.4	93.4	95.3	94.3	93.8
Average/tiger		<b>94.6</b>	<b>95.7</b>	<b>93.1</b>	<b>95.7</b>	<b>95.0</b>	<b>94.7</b>
Disc	Mas40F	93.4	91.9	93.4	91.3	92.4	92.5
	Dartona	93.4	90.3	93.4	93.5	93.2	92.8
	P9911	96.8	91.9	96.8	94.3	95.3	95.0
Average/disc		<b>94.5</b>	<b>94.5</b>	<b>91.4</b>	<b>94.5</b>	<b>93.0</b>	<b>93.4</b>
Average/year		<b>94.9</b>	<b>92.7</b>	<b>94.9</b>	<b>93.5</b>	<b>93.6</b>	<b>94.0</b>

In the experiment located in Osmancea, Constanța, the weed species present in the corn crop were: *Chenopodium album*, *Convolvulus arvensis*, *Sorghum halepense* from seed and rhizomes and *Xanthium spinosum*.

The average density of weed species (no./m<sup>2</sup>), averaged over the years of experimentation and hybrids, is presented in table 2. The highest density was recorded for the species *Sorghum halepense* from the seed 68.4 plants/m<sup>2</sup>, followed by the species *Convolvulus arvensis* with a number of 27.6

plants/m<sup>2</sup>, *Xanthium spinosum* 18.6 plants/m<sup>2</sup>, *Sorghum halepense* from rhizomes 14.0 plants/m<sup>2</sup> and *Fumaria officinalis* 9.2 plants/m<sup>2</sup> (Table 2).

Tillage influences the number of weeds/m<sup>2</sup>, the highest weed density was recorded in the variants where the basic tillage consisted of a disk tillage 65.2 weeds/m<sup>2</sup>, followed by the tiger tillage 44 weeds/m<sup>2</sup> and the lowest percentage of weeds/m<sup>2</sup> was recorded in the plowing work 28.6 weeds/m<sup>2</sup> (Table 2).

Table 2. Average weed density/m<sup>2</sup>/species according to tillage

Tillage	Weeds (no./m <sup>2</sup> )				
	<i>Convolvulus arvensis</i>	<i>Sorghum halepense</i>		<i>Xanthium spinosum</i>	<i>Fumaria officinalis</i>
		Seed	Rhizome		
Plowing	4.4	14.4	3.7	4.4	1.7
Tiger	6.6	24.9	4.5	6.2	1.9
Disc	16.6	29.1	5.8	8.0	5.7
<b>TOTAL</b>	<b>27.6</b>	<b>68.4</b>	<b>14.0</b>	<b>18.6</b>	<b>9.2</b>

To determine the influence of each factor, but also their interaction, on corn production, the analysis of variance for the polyfactorial experience (3 × 3 × 5) was performed.

Analyzing the variance table for the polyfactorial experience, we observe the very significant influence of factor A (tillage), factor B (hybrid) and C (year of

experimentation) on production. The interactions between the experimental factors were very significant, and the triple interaction A x B x C was also very significant, but the greatest influence on the corn production obtained was the factor C and the climatic conditions of the experimental year (Table 3).

Table 3. Analysis of variance (ANOVA) for production at multifactorial experiment

Source of Variation	Sum of Squares (SS)	Degrees of Freedom (DF)	Mean Squares (MS)	F-test
Tillage	60249984.4	2	30124992.2	1102.3***
Hybrid	646579.2	2	323289.6	28.4***
Tillage x Hybrid	1463556.8	4	365889.2	32.1*
Years	1581391583.1	4	395347895.8	36987.5***
Tillage x Years	47366234.9	8	5920779.4	553.9***
Hybrid x Years	716394.1	8	89549.3	8.4***
Tillage x Hybrid x Years	1595091.9	16	99693.2	9.3***

Analyzing the average productions obtained with the combination of soil work x hybrid factors we can see that when the land is worked with the tiger, very significant production increases of 522 kg/ha are obtained compared to the work with plowing as the basic work and a very significant increase of 1604 kg /ha compared to disc

tillage as a base tillage (Table 4). When the basic work consists of plowing, production increases of 1082 kg/ha are obtained compared to the work with the disc, and in the case of the work with the disc, the productions decrease by up to 1604 kg/ha (Table 7).

Table 4. The influence of experimental factors tillage and hybrid on corn yields

Factor	Yields (kg/ha)			
	Mas40F	Dartona	P9911	Average tillage
Plowing	7134	7006	7484	7208
Tiger	7793	7739	7660	<b>7730</b>
Disc	6069	6107	6202	6126
Average hybrid	6999	6951	<b>7116</b>	

The influence of the hybrid on corn production is evident in the level of productions obtained, the cultivation of the P9911 hybrid brought a very significant increase in production of 165 kg/ha compared to the Dartona hybrid and 117 kg/ha compared to the Mas40F hybrid. The difference in production obtained between the maize hybrid Mas40F and Dartona is insignificant (Table 7).

At the combination of soil work x experiment year factors we can see that in the

2019 and 2020 experiment years, unfavorable years for the corn crop, the level of production was higher with the basic plow work compared to the tiger and disc work variant. The water from the precipitation is used differently by the corn plants depending on the technology used, so in years with lower precipitation the plants use the water best when they are sown in plowing, and in rainy years when working with the tiger (Table 5).

Table 5. The influence of experimental factors tillage and years of experimentation on corn yields

Factor	Yields (kg/ha)					Average tillage
	2017	2018	2019	2020	2021	
Plowing	11134	10514	<b>5866</b>	<b>2891</b>	5637	7208
Tiger	13116	11862	5094	2700	5880	<b>7730</b>
Disc	11220	8179	4032	2450	4750	6126
Average years	<b>11824</b>	10185	4997	2680	5422	

The year of experimentation has a very significant influence on the productions obtained, the most favorable year was 2017, when a production of 11824 kg/ha was obtained, and the most unfavorable year was 2020, when a production of 2680 kg was obtained/ha (Table 5).

Regarding the influence of the hybrid on the combination of factors year of

experimentation x hybrid, we can see that regardless of the year of experimentation the hybrid P9911 obtains very significant increases in production compared to the other 2 cultivated hybrids, with the exception of 2017 when the difference between the hybrid Dartona and P9911 was 10 kg/ha, insignificant difference (Table 6).

Table 6. The influence of experimental factors hybrid and years of experimentation on corn yields

Factor	Yields (kg/ha)					
	2017	2018	2019	2020	2021	Average hybrid
Mas40F	11699	10295	4932	2670	5398	6999
Dartona	11891	9957	4978	2597	5332	6951
P9911	11881	10304	5082	2774	5537	<b>7116</b>
Average years	<b>11824</b>	10185	4997	2680	5422	

Table 7. Limit differences for all combinations of factors

LSD (kg/ha)	For tillage	For hybrid	For years
5%	96.89	49.06	55.99
1%	160.31	68.87	74.57
0.01%	300.07	97.22	96.51
LSD (kg/ha)	a1b2-a1b1	a2b2-a1b1	a1c2-a1c1
5%	84.98	100.92	48.74
1%	119.28	156.97	96.99
0.01%	168.40	268.05	129.15
LSD (kg/ha)	b1c2-b1c1	b2c2-b1c2	a2c2-a1c2
5%	96.99	94.20	115.07
1%	129.15	126.98	170.77
0.01%	167.17	167.86	272.90
LSD (kg/ha)	a1b1c2-a1b1c1	a1b2c1-a1b1c1	a2b1c1-a1b1c1
5%	167.98	163.16	190.13
1%	223.70	219.93	267.22
0.01%	289.54	290.75	386.19

## CONCLUSIONS

The evolution of climatic conditions after sowing and the tillage system influence the percentage of plants that have emerged. The highest percentage of emergence was obtained in the work carried out with the tiger, when the corn benefited from temperature and humidity at the level of the specific requirements of the crop.

Tillage influences the number of weeds/m<sup>2</sup>, the highest weed density was recorded in the variants where the basic tillage consisted of a

disk tillage, followed by the tiger tillage and the lowest percentage of weeds/m<sup>2</sup> was registered in the plowing work.

The highest productions were obtained with the basic work performed with the tiger, followed by the variants where the basic soil work consisted of plowing, and the lowest with the variant disk. The establishment of the soil preparation system is carried out depending on the soil conditions, climate and the crop plant, and for the south-eastern area of Romania, for the corn culture, the basic tillage carried out with the tiger is recommended.

For a safe corn production, it is recommended to use at least 2 corn hybrids, from different maturity groups, because they behave differently in the climatic conditions of the year.

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