Research regarding the influence of soil tillage and fertilization on corn hybrids (*Zea mays* L.) grown in Osmancea area, Constanța County, Romania

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Abstract. To achieve profitable corn crops, implementing agricultural practices that consider soil conservation, due to its limited character as an agricultural resource, it is necessary first of all to identify and use the most efficient soil tillage types. Secondly, this approach must be supplemented by a careful selection of productive hybrids, adapted to the pedologic and climatic conditions of an area, and by a fertilization management defined in accordance to the crop's requirements. Research conducted within Micul Agricultor SRL, Osmancea, Constanta County, during the agricultural years 2016-2017 and 2017-2018, closely illustrates this approach with the purpose of highlighting the best combination of technological factors for growing corn in this area. This paper presents the development results of three corn hybrids, Mas 40 F, Dartona and P 9911, recorded following the use of different soil tillage types, applied using a plough, a tiger and a disc and for the use of the following fertilization levels: unfertilized ($N_0P_0K_0$), mineral fertilization with $N_{90}P_{40}K_{40,}$ and mineral and starter fertilization with $N_{90}P_{40}K_{40}$ + Microgranulated Biostimulator (16 N – 40 P_2O_5 + 2 MgO + 5 SO_3 + 2 Zn, further mentioned as MB). The best results in terms of seeds emergence, yield and a thousand seeds weight were recorded for the variant where the basic soil tillage was carried out with tiger and mineral and starter fertilization was applied. Yield and a thousand seeds weight increased as fertilizer doses increased. Using the disk for basic soil tillage had negative effects on the percentage of emerged plants, but also reduced yield and a thousand seeds weight, while weed infestation was higher compared to the other tillage types. Results show that soil tillage and fertilization were the main factors influencing crop's yield and development, followed by hybrid selection. Knowing the effects of tillage types, combined with fertilization, and hybrid selection is important in developing crop management practices adapted to the condition of a specific area, that will ensure an equilibrium between farmers' need to increase yields and resources conservation.

Key Words: corn yield, minimum tillage, conventional tillage, starter biostimulator, weeds control.

Introduction. Soil tillage systems evolved considerably in the last decades, both in the world, and in Romania, following the extension of the conservative methods of soil tillage, to meet the needs of preserving soil properties and reduce erosion (Subbulakshmi et al 2009; Busari et al 2015). Conservation soil tillage is nevertheless ambiguous in terms of tillage types, referring to a broad range of soil disturbance and residue incorporation types (Derpsch et al 2014 in Reicosky 2015) carried out with the purpose of conserving soil, water, and even time or fuel (Baker et al 2002 in Reicosky 2015).

While the use of conventional tillage, due to the intensity of soil disturbance and the removal of crop residues can affect soil fertility, also increasing evaporation and soil erosion (Lal 1991), reduced tillage and no-tillage types have a positive influence on soil organic matter (Rhoton 2000; Alvarez 2005; Anikwe & Ubochi 2007), water content (Roldan et al 2003; Becher 2005; Romaneneckas et al 2013; Copec et al 2015) and soil physical properties (McVay et al 2006; Bartlová et al 2015), all these positively influencing crops' development and yield.

In Romania minimum and no-tillage systems were introduced as conservation tillage practices at Fundulea Research Institute in 1960 but their implementation was not extensive due to weeds development and lack of technology (Calistru & Jitareanu 2014). Studies carried out by Oncica et al (2016) on various corn hybrids grown using both conventional and minimum tillage systems highlighted the superiority of the minimum soil tillage system, considering its influence on plants morphological and yield properties.

Research conducted by Cociu (2010) on the chernozem of Fundulea Research Center highlighted higher yields of corn for minimum tillage (chisel) compared to conventional tillage (plow), but yield was highly correlated to soil water reserve, in restrictive humidity conditions. A research carried out on a corn crop grown in Transylvanian Plain (Cheţan et al 2016) showed that yield recorded for minimum and conventional soil tillage do not differ with statistically assured values, a slightly higher yield being recorded for chisel (5,693 kg ha^{-1}) compared to plowing (5,671 kg ha^{-1}). Moraru & Rusu (2011) highlight a neglectable yield difference between conventional and minimum soil tillage, the latest with a yield representing between 96 and 99.8% of the yield obtained for classic tillage. Similar result where recorded in Transylvanian Plain by Rusu et al (2009a,b, 2011), corn yield for minimum tillage representing 92 to 98% of the conventional soil tillage. Research on the influence of soil tillage systems on corn yield confirmed that the smallest yield was achieved by tillage with disk, while the alternative tillage chisel+disk generated the highest yields (Marin et al 2015).

Considering these results, soil tillage type and conservation systems in different areas must be differentiated according to the ecological characteristics of the area and the technological requirements of the plants grown (Guş et al 2004).

Along soil tillage, macro-nutrients have a decisive role in corn crop development and yield, some authors highlighting that fertilizers are better used when tillage is conducted at higher depths (Jitareanu et al 2007). Filipović et al (2016) believes that one of the many factors contributing to yield increase and its quality is a balanced fertilization. In the absence of fertilization yields decrease year after year due to the decrease of soil fertility (Kumar et al 2000). The stages of applying fertilizers is also important, Gott et al (2014) obtained the best yield results when nitrogen fertilization was carried out in stages of 2, 4 and 8 leaves, and foliar fertilization was carried out in stages of 2, 4, 6, and 8 leaves. Much more the amount of rainfall and the moment of their fall influence the crop's yield, thus a research conducted in the period of 1961-2013, in Bulgaria, highlighted the correlation of different NPK fertilizer doses with the rainfall regime in terms of the positive influence on the corn crop (Moteva et al 2017). A research conducted at S.C.D.A. Secuieni (Lupu et al 2015) shows that climatic conditions had a decisive role in improving nitrogen assimilation and increasing corn yield.

Wang et al (2012) emphasize that the most important factor in obtaining high yields of corn is choosing hybrids with high biological potential, feasible to be sown at high densities, resistant to drought, heat and disease and tolerant to some herbicides.

Climatic and soil condition play a decisive role in optimizing the agricultural practice, and considering different results recorded under the influence of specific research factors, a specialized, local research should be carried out in order to improve crop technology for a certain area. Thus, the purpose of this paper was to find the best fitted soil tillage types, doses and types of fertilizers, and the most productive hybrids, for the pedologic and climatic conditions of Osmancea area, Constanţa County.

Material and Method. The research was carried out during the agricultural years 2016-2017 and 2017-2018 within Micul Agricultor SRL farm, located in Osmancea, Constanţa County. The field experience was conducted on a Cambic Chernozem of the Cernisoils class. Soil structure was clay loam. The top soil layer was neutral (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).

Osmancea, Constanţa County, is located in a temperate continental area with a multiannual average temperature (for 30 years) of 12.1°C. The average annual temperature recorded in 2017 was 12.8°C with 0.7°C above the multiannual average,

and in 2018 average annual temperature was 13.1°C, with 1.0°C higher than the average multiannual value.

During the research period, 2017-2018, temperatures, although higher than the multiannual average, were favorable to corn plants. However, the minimum temperatures in April 2017 were low, thus prolonging germination.

The multiannual rainfall amount (30 years) recorded in Osmancea area was 430.2 mm. In 2017, 569.5 mm of rainfall was recorded, with 139.3 mm more than the multiannual value. Between April and July, the amount of rainfall was higher compared to the multiannual value, allowing a good development of the corn crop. August recorded lower amounts of rainfall (by 5.2 mm) compared to the multiannual value.

In 2018 rainfalls were abundant, recording 756.05 mm, 325.85 mm above the annual value. Between May and July, it rained over 100 mm month^{-1}, favoring corn plants development.

The field research was build using the split plot design: 3 x 3 x 3, with three replications:

The factors studied were as follows:
Factor A - soil tillage:
a_1: plough tillage (Control),
a_2: tiger tillage,
a_3: disk tillage.

Factor B - fertilization level:
b_1: $N_0P_0K_0$ (Control),
b_2: $N_{90}P_{40}K_{40}$,
b_3: $N_{90}P_{40}K_{40}$ + MB (starter microgranulated biostimulator: 16 N – 40 P_2O_5 + 2 MgO + 5 SO_3 + 2 Zn) at a dose of 25 kg ha^{-1}.

Factor C - hybrid:
c_1: MAS 40 F,
c_2: Dartona,
c_3: P 9911.

Winter wheat was used as the preceding crop of the corn crop. Soil tillage and fertilization were performed according to the research protocol. Sowing was carried out randomized, at a density of 64,200 germinating seed/ha and a depth of 5 cm. Seeds were treated by the producing company using a pest repellent and fungicidal products.

Weed control was carried out before emergence with 212.5 g L^{-1} dimethenamid-P and 250 g L^{-1} pendimethalin at a dose of 3.5 L ha^{-1}.

Crop density after emergence, weeds extent degree (numerical method), and yield where recorded as the results of the research. A thousand seeds weight, yield and harvest humidity were determined in the laboratory, while grain yield per hectare and a thousand seeds weight at 14% humidity were calculated.

Statistical analysis. The average data of the two agricultural years where statistical analyzed using two-way ANOVA, thus calculating the degrees of freedom and comparing the mean values of factors using Fishers Least Significant Difference (LSD) test.

Results and Discussion

Corn plants' rate of emergence under the influence of tillage and fertilization. Field experiments conducted during 2017-2018 revealed that soil basic tillage and fertilization influenced the percentage of emerged plants (Figure 1). When moldboard plowing was used, the percentage of emerged plants was 94% in the unfertilized variant and fertilized with $N_{90}P_{40}K_{40}$ and of 95% in the variant fertilized with $N_{90}P_{40}K_{40}$ + MB - 25 kg ha^{-1}.

The percentage of emerged plants increased due to the use of tiger for the basic soil tillage, from 94% in the unfertilized variant to 95% in the variant fertilized with $N_{90}P_{40}K_{40}$ + MB - 25 kg ha^{-1}. The use of disk to perform the basic soil tillage led to a decrease in the percentage of emerged plants for all variants, which ranged from 92% in the unfertilized variant to 93% in the variant fertilized with $N_{90}P_{40}K_{40}$ + MB - 25 kg ha^{-1}. Considering factors interaction, soil tillage x fertilization x hybrid, the percentage of emerged plants was of 94% for plowing and tiger tillage and 93% for disk tillage (Figure 1).

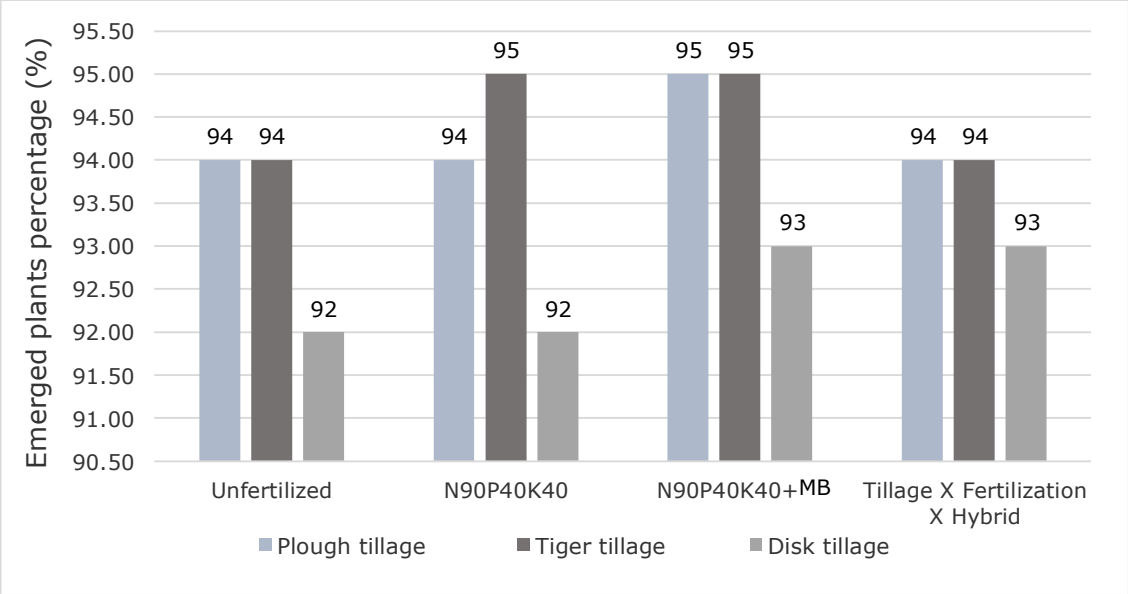

Figure 1. The percentage of emerged plants influenced by soil tillage, fertilization and hybrid, Osmancea 2017-2018.

Soil tillage and fertilization influence on weeds species development. Weeds species identified in the corn crop were: *Convolvulus arvensis, Sorghum halepense* from seed and rhizomes, *Chenopodium album* and *Xanthium spinosum*.

The interaction between soil tillage and fertilization revealed that the total number of weeds per square meter (m^2) increased due to these factors, mostly influenced by the tillage type, which preserved different amounts of weeds seeds in the top layer of the soil. The average weeds density for plowing tillage on different fertilization levels was of 92 plants m^{-2}, with the highest value of 107 plants m^{-2} for the unfertilized variant, and the lowest value, of 83 plants m^{-2}, for the fertilization level $N_{90}P_{40}K_{40}$ + MB – 25 kg ha^{-1}. Using tiger as basic soil tillage resulted in an increase in the average number of weeds m^{-2} to 127 plants, while the highest value of 146 plants/m^2 was recorded for the fertilization level $N_{90}P_{40}K_{40}$ + MB - 25 kg ha^{-1} and a minimum value of 102 plants $m^{-2}$for the fertilization level $N_{90}P_{40}K_{40}$. The highest density of weeds was recorded in the variant where the basic soil tillage was carried out with the disk, with an average of 160 plants m^{-2}, their number decreased from 217 plants m^{-2} (unfertilized) to 124 plants m^{-2} (fertilization level $N_{90}P_{40}K_{40}$ + MB – 25 kg ha^{-1}, Figure 2).

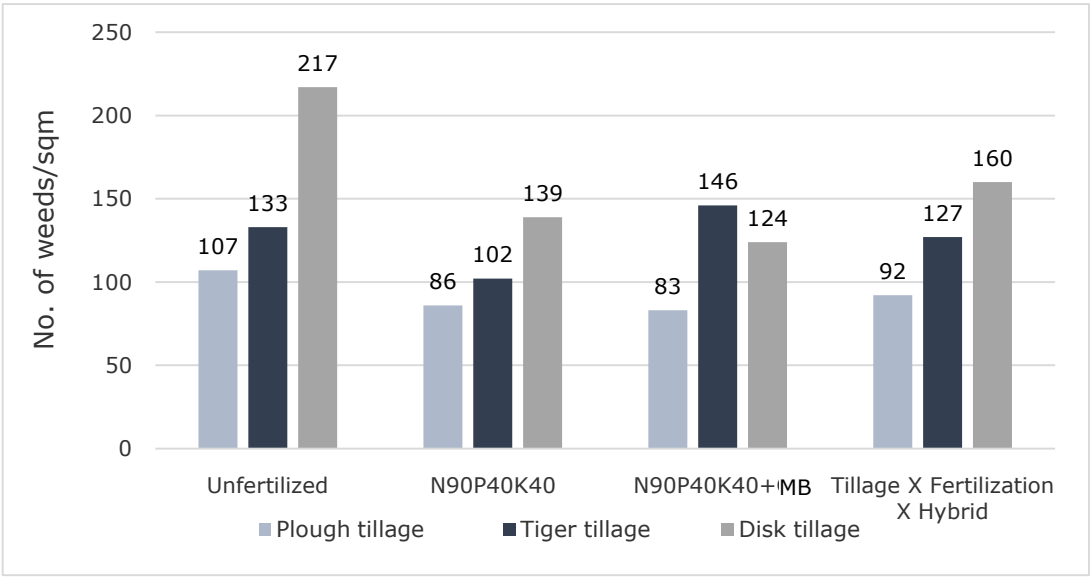

Figure 2. Influence of soil tillage and fertilization on weeds species development in the corn crop, Osmancea 2017-2018.

Soil tillage, fertilization and hybrid influence on corn yield. Research conducted during the agricultural years 2016-2017 and 2017-2018 showed that the basic soil tillage type, along with fertilization and the selection of corn hybrids had a decisive influence on corn yield. Control variants, against which the yield increases were calculated for the hybrids MAS 40 F, DARTONA, P 9911, were unfertilized variants, where soil tillage was carried out with the plough.

Yield increases recorded for the hybrid MAS 40 F, compared to control, were very significant ($P<0.001$) for the fertilized variants where plowing and tiger tillage was applied, distinctly significant ($P<0.01$) for disk tillage, when it was fertilized with $N_{90}P_{40}K_{40}$ + MB, and distinctly significant negative in the variant where the basic soil tillage was performed with the disk and fertilization was not used. When the basic soil tillage was conducted with tiger and fertilizers were not applied, and also when the basic soil tillage was conducted with disk for the fertilization level $N_{90}P_{40}K_{40}$, the yield increase compared to control was very small, statistically insignificant ($P>0.05$) (Table 1).

Table 1

Soil tillage and fertilization influence on the yield of the corn hybrid MAS 40 F (t ha^{-1}), Osmancea, average 2017-2018

Soil tillage	*Fertilization level*	*MAS 40 F hybrid*		
		Yield (t ha^{-1})	(%)	Diff. (t ha^{-1})
Plowing	$N_0P_0K_0$	8.95	100	Ct
	$N_{90}P_{40}K_{40}$	10.67	119.2	1.7^{***}
	$N_{90}P_{40}K_{40}$+MB	12.72	142.1	3.8^{***}
Tiger	$N_0P_0K_0$	9.35	104.5	0.4^{ns}
	$N_{90}P_{40}K_{40}$	12.44	139.0	3.5^{***}
	$N_{90}P_{40}K_{40}$+MB	13.48	150.6	4.5^{***}
Disk	$N_0P_0K_0$	7.61	85.0	-1.3^{oo}
	$N_{90}P_{40}K_{40}$	8.91	99.6	0.04^{ns}
	$N_{90}P_{40}K_{40}$+MB	10.14	113.3	1.2^{**}

LSD 5% = 0.44 t ha^{-1}; LSD 1% = 0.74 t ha^{-1}; LSD 0.1% = 1.46 t ha^{-1}; MB = microgranulated biostimulator.

Dartona hybrid achieved very significant yield increases ($P<0.001$) compared to control for the most variants (Table 2). Exceptions were recorded for the plowed variant,

fertilized with $N_{90}P_{40}K_{40}$ and the disked variant fertilized with $N_{90}P_{40}K_{40}$ + MB (Table 2), where the increase in yield was distinctly significant positive ($P<0.01$). A distinctly significant yield reduction was recorded for the unfertilized variant and disk tillage. For tiger, unfertilized, and disk tillage, fertilized with $N_{90}P_{40}K_{40}$ + MB statistically insignificant ($P>0.05$) yield decreases were recorded (Table 2).

Table 2

Soil tillage and fertilization influence on the yield of the corn hybrid Dartona (t ha^{-1}), Osmancea, average 2017-2018

Soil tillage	*Fertilization level*	*Dartona hybrid*		
		Yield (t ha^{-1})	(%)	Diff. (t ha^{-1})
Plowing	$N_0P_0K_0$	8.96	100	Ct
	$N_{90}P_{40}K_{40}$	10.47	116.9	1.5^{**}
	$N_{90}P_{40}K_{40}$+MB	12.90	144.0	3.9^{***}
Tiger	$N_0P_0K_0$	9.48	105.8	0.5^{ns}
	$N_{90}P_{40}K_{40}$	12.04	134.4	3.0^{***}
	$N_{90}P_{40}K_{40}$+MB	13.09	146.1	4.1^{***}
Disk	$N_0P_0K_0$	7.47	83.4	-1.5^{oo}
	$N_{90}P_{40}K_{40}$	8.91	99.4	-0.1^{ns}
	$N_{90}P_{40}K_{40}$+MB	10.20	113.8	1.2^{**}

LSD 5% = 0.59 t ha^{-1}; LSD 1% = 0.92 t ha^{-1}; LSD 0.1% = 1.6 t ha^{-1}; MB = microgranulated biostimulator.

The hybrid P 9911 also behaved very well under the conditions of the Osmancea area. Yields were high, with very significant ($P<0.001$) and distinctly significant ($P<0.01$) increases were recorded compared to control (the unfertilized, plowed variant). A distinctly significant negative yield difference was recorded when the basic soil tillage was carried out with the disk and fertilization was not ensured. Same as MAS 40 F and Dartona hybrids, P9911 hybrid recorded insignificant yield increases ($P>0.05$) for the variants tiger tillage x unfertilized (Table 3).

Table 3

Soil tillage and fertilization influence on the yield of the corn hybrid P 9911 (t ha^{-1}), Osmancea, average 2017-2018

Soil tillage	*Fertilization level*	*P 9911 hybrid*		
		Yield (t ha^{-1})	(%)	Diff. (t ha^{-1})
Plowing	$N_0P_0K_0$	9.16	100	Ct
	$N_{90}P_{40}K_{40}$	11.25	122.8	2.1^{****}
	$N_{90}P_{40}K_{40}$+Gr	12.88	140.6	3.7^{***}
Tiger	$N_0P_0K_0$	9.52	103.9	0.4^{ns}
	$N_{90}P_{40}K_{40}$	11.96	130.6	2.8^{***}
	$N_{90}P_{40}K_{40}$+Gr	13.52	147.6	4.4^{***}
Disk	$N_0P_0K_0$	7.44	81.2	-1.7^{ooo}
	$N_{90}P_{40}K_{40}$	9.11	99.5	-0.1^{ns}
	$N_{90}P_{40}K_{40}$+Gr	10.30	112.4	1.1^{**}

LSD 5% = 0.42 t ha^{-1}; LSD 1% = 0.69 t ha^{-1}; LSD 0.1% = 1.29 t ha^{-1}; MB = microgranulated biostimulator.

The effects of soil tillage and fertilization on the average yield of the researched corn hybrids materialized in higher yields for most variants. Compared to the average yield of the three hybrids (MAS 40 F, Dartona and P 9911) obtained for the unfertilized, plowed variant (Control), yield increases generated by the other variants were statistically ensured except for the tiger tillage x $N_0P_0K_0$ and disk tillage x fertilized $N_{90}P_{40}K_{40}$ variants that recorded small yield differences compared to control (Table 4).

Table 4

Soil tillage and fertilization influence on the average yield of the three corn hybrids (t ha^{-1}), Osmancea average 2017-2018

Soil tillage	*Fertilization level*	*Hybrids' average*		
		Yield (t ha^{-1})	(%)	Diff. (t ha^{-1})
Plowing	$N_0P_0K_0$	9.02	100	Ct
	$N_{90}P_{40}K_{40}$	10.80	119.7	1.78^{***}
	$N_{90}P_{40}K_{40}$+MB	12.83	142.2	3.81^{***}
Tiger	$N_0P_0K_0$	9.45	104.2	0.43^{ns}
	$N_{90}P_{40}K_{40}$	12.15	134.7	3.13^{***}
	$N_{90}P_{40}K_{40}$+MB	13.36	148.1	4.34^{***}
Disk	$N_0P_0K_0$	7.51	83.3	-1.51^{ooo}
	$N_{90}P_{40}K_{40}$	8.98	99.6	-0.04^{ns}
	$N_{90}P_{40}K_{40}$+MB	10.21	113.2	1.19^{**}

LSD 5% = 0.48 t ha^{-1}; LSD 1% = 0.78 t ha^{-1}; Dl 0.1% = 1.45 t ha^{-1}; MB = microgranulated biostimulator.

Soil tillage, fertilization and hybrid influence on corn thousand seeds weight (TSW). A thousand seeds weight of the cultivated hybrids varied depending on soil tillage, fertilization and hybrids, as the conditions specific to the years 2017 and 2018 were favorable for the corn crop.

MAS 40 F hybrid recorded values of the thousand seeds weight between 235.3 g (disk tillage x unfertilized) and 345.5 g (tiger tillage x fertilized with $N_{90}P_{40}K_{40}$ + MB). Comparing the values of a thousand seeds weight for each variant to control (plowed and unfertilized variant), statistically assured differences ($P<0.05$) were obtained. Exceptions were recorded for tiger unfertilized and disk fertilized with $N_{90}P_{40}K_{40}$, with small differences compared to control, statistically insignificant (Table 5). A very significant decrease was recorded for the variant disk x unfertilized, that generated a TWS with -33.0 g lower than control.

Table 5

Soil tillage and fertilization influence on MAS 40 F hybrid TSW (g), Osmancea, average 2017-2018

Soil tillage	*Fertilization level*	*MAS 40 F hybrid*		
		TSW (g)	(%)	Diff. (g)
Plowing	$N_0P_0K_0$	268.3	100	Ct
	$N_{90}P_{40}K_{40}$	280.7	104.6	12.4^{**}
	$N_{90}P_{40}K_{40}$+MB	338.7	126.2	70.4^{***}
Tiger	$N_0P_0K_0$	275.3	102.6	7.0^{ns}
	$N_{90}P_{40}K_{40}$	321.8	119.9	53.5^{***}
	$N_{90}P_{40}K_{40}$+MB	345.5	128.8	77.2^{***}
Disk	$N_0P_0K_0$	235.3	87.7	-33.0^{ooo}
	$N_{90}P_{40}K_{40}$	261.7	97.5	-6.6^{ns}
	$N_{90}P_{40}K_{40}$+MB	281.0	104.7	12.7^{*}

LSD 5% = 8.03 g; LSD 1% = 12.33 g; LSD 0.1% = 20.39 g; MB = microgranulated biostimulator.

Dartona hybrid recorded values for a thousand seeds weight between 231.0 g (disk tillage x unfertilized) and 339.0 g (tiger tillage x fertilized with $N_{90}P_{40}K_{40}$ + MB), these being the extreme values. Differences compared to control were statistically assured ($P<0.05$) for all variants (Table 6).

Table 6

Soil tillage and fertilization influence on Dartona hybrid TSW (g), Osmancea, average 2017-2018

Soil tillage	*Fertilization level*	*Dartona hybrid*		
		TSW (g)	(%)	Diff. (g)
Plowing	$N_0P_0K_0$	270.7	100	Ct
	$N_{90}P_{40}K_{40}$	303.3	112.0	32.6^{***}
	$N_{90}P_{40}K_{40}$+MB	337.7	124.8	67.0^{***}
Tiger	$N_0P_0K_0$	279.7	103.3	9.0^{*}
	$N_{90}P_{40}K_{40}$	322.3	119.1	51.6^{***}
	$N_{90}P_{40}K_{40}$+MB	339.0	125.2	68.3^{***}
Disk	$N_0P_0K_0$	231.0	85.3	-39.7^{ooo}
	$N_{90}P_{40}K_{40}$	263.7	97.4	-7.0^{o}
	$N_{90}P_{40}K_{40}$+MB	281.3	103.9	10.6^{**}

LSD 5% = 5.39 g; LSD 1% = 9.12 g; LSD 0.1% = 18.34 g; MB = microgranulated biostimulator.

A thousand seeds weight of the hybrid P9911 was also influenced by soil tillage and fertilization (Table 7). This recorded values between 234.3 g (disk tillage x unfertilized) and 351 g (tiger tillage x fertilized $N_{90}P_{40}K_{40}$ + MB). A thousand seed weight differences for most variants were statistically assured, except for the variants tiger, unfertilized, and disk, fertilized $N_{90}P_{40}K_{40}$, where the differences compared to control were small and statistically not significant (P>0.05).

Table 7

Soil tillage and fertilization influence on P 9911 hybrid TSW (g), Osmancea, average 2017-2018

Soil tillage	*Fertilization level*	*P 9911 F hybrid*		
		TSW (g)	(%)	Diff. (g)
Plowing	$N_0P_0K_0$	264.3	100	Ct
	$N_{90}P_{40}K_{40}$	300.7	113.8	36.4^{**}
	$N_{90}P_{40}K_{40}$+MB	336.0	127.1	71.7^{***}
Tiger	$N_0P_0K_0$	270.3	102.3	6.0^{ns}
	$N_{90}P_{40}K_{40}$	320.3	121.2	56.0^{***}
	$N_{90}P_{40}K_{40}$+MB	351.0	132.8	86.7^{***}
Disk	$N_0P_0K_0$	234.3	88.6	-30.0^{oo}
	$N_{90}P_{40}K_{40}$	263.3	99.6	-1.0^{ns}
	$N_{90}P_{40}K_{40}$+MB	298.0	112.8	33.7^{**}

LSD 5% = 11.65 g; LSD 1% = 19.88 g; LSD 0.1% = 39.69 g; MB = microgranulated biostimulator.

The three corn hybrids recorded an average value of a thousand seeds weight between 233.5 g (disk tillage x unfertilized) and 345.2 g (tiger tillage x fertilized $N_{90}P_{40}K_{40}$ + MB) (Table 8).

For plowing tillage, a thousand seeds weight recorded values of 294.9 g for the variant fertilized with $N_{90}P_{40}K_{40}$ and 337.5 for the variant fertilized with $N_{90}P_{40}K_{40}$ + MB, with very significant differences compared to control (267.8 g), of 27.1 g and 69.7 g respectively (Table 8).

Soil tillage performed with tiger influenced the TSW of all three hybrids, compared to the unfertilized, plowed variant (control), generating increases of 7.3 g for the unfertilized variant, 53.7 g for the variant fertilized with $N_{90}P_{40}K_{40}$ and 77.4 g for the variant where starter fertilization was used when sowing, along with the application of $N_{90}P_{40}K_{40}$ (Table 8).

A thousand seeds weight obtained by the hybrids for disk tillage x unfertilized variant was lower than control by 34.3 g, a very significant negative difference

(P<0.001). For the fertilization level $N_{90}P_{40}K_{40}$, corn hybrids' TSW was 4.9 g lower compared to control, but the difference was insignificant (P>0.05). Using starter fertilization, TSW value increased by 19 g compared to control, a distinctly significant difference (Table 8).

Table 8

Soil tillage and fertilization influence on the average TWS (g) of the three corn hybrids, Osmancea, average 2017-2018

Soil tillage	*Fertilization level*	*Hybrids average*		
		TSW (g)	(%)	Diff. (g)
Plowing	$N_0P_0K_0$	267.8	100	Ct
	$N_{90}P_{40}K_{40}$	294.9	110.1	27.1^{***}
	$N_{90}P_{40}K_{40}$+MB	337.5	126.0	69.7^{***}
Tiger	$N_0P_0K_0$	275.1	102.7	7.3^{ns}
	$N_{90}P_{40}K_{40}$	321.5	120.1	53.7^{***}
	$N_{90}P_{40}K_{40}$+MB	345.2	128.9	77.4^{***}
Disk	$N_0P_0K_0$	233.5	87.2	-34.3^{ooo}
	$N_{90}P_{40}K_{40}$	262.9	98.2	-4.9^{ns}
	$N_{90}P_{40}K_{40}$+MB	286.8	107.1	19.0^{**}

LSD 5% = 8.33 g; LSD 1% = 13.78 g; LSD 0.1% = 26.14 g; MB = microgranulated biostimulator.

Conclusions. In the soil and climatic conditions of Osmancea area (Constanța County), for the agricultural years 2016-2017 and 2017-2018, we could observe that soil tillage and hybrid influenced the percentage of emerged plants. Plowing and the use of tiger for the basic soil tillage determined the highest percentage of emerged seedlings, with average values between 94.0% and 94.1%. Using disk for basic soil tillage ensured a 93.1% germination rate.

Tillage also had an influence of the number of weeds developing in the corn crop. Due to the fact that weeds were previously controlled using a rational crop rotation, species composition was limited to weeds that are harder to manage: *C. arvensis, S. halepense* from seed and rhizomes, *C. album* and *X. spinosum*. Soil tillage performed using disk generated the highest number of weeds per surface unit, 160 plants m^{-2}.

Soil tillage, fertilization and hybrid influenced corn yield and a thousand seeds weight. The highest yield, with an average value of the three hybrids of 13.36 t ha^{-1}, was obtained for the variant where tiger was used for the basic soil tillage and starter fertilization (25 kg ha^{-1} MB) was applied along with $N_{90}P_{40}K_{40}$ mineral fertilization. For this variant (tiger tillage x fertilized $N_{90}P_{40}K_{40}$ + MB), P9911 hybrid recorded the highest yield of 13.52 t ha^{-1}, while MAS 40 F hybrid had a yield of 13.48 t ha^{-1}, and Dartona hybrid obtained 13.09 t ha^{-1}.

The average thousand seeds weight of the three hybrids recorded the highest value of 345.2 g for the variant where tiger was used for basic soil tillage and the fertilization $N_{90}P_{40}K_{40}$+25 kg ha^{-1} MB was applied. Thus, P9911 obtained a value of 351 g, MAS 40 F hybrid recorded a TSW of 345.5 g, and Dartona had a value of 339.0 g.

Using disk for basic soil tillage, combined with the lack of fertilization generated the lowest yields and TSW values of the three corn hybrids.

References

Alvarez R., 2005 A review of nitrogen fertilizer and conservation tillage effects on soil organic carbon storage. Soil Use and Management 21(1):38–52.

Anikwe M. A., Ubochi J. N., 2007 Short them changes in soil properties under tillage systems and their effect on sweet potato growth and yield in an Ultisol in south-eastern Nigeria. Australian Journal of soil Research 45:351-358.

Bartlová J., Badalíková B., Pospíšilová L., Pokorný E., Šarapatka B., 2015 Water stability of soil aggregates in different systems of tillage. Soil and Water Research 10(3)147-157.
Becher H. H., 2005 Impact of the long-term straw supply on loess derived soil structure. International Agrophysiology 19:199-202.
Busari M. A., Kukal S. S., Kaur A., Bhatt R., Dulazi A. A., 2015 Conservation tillage impacts on soil, crop and the environment. International Soil and Water Conservation Research 3(2):119-129.
Calistru A. E., Jitareanu G., 2014 No-tillage around the world. Revista Lucrari Stiintifice, Seria Agronomie 57:11-15,
Chetan F., Rusu T., Chetan C., Moraru P. I., 2016 Influence of soil tillage upon weeds, production and economic efficiency of corn crop. Bucharest-AgroLife Scientific Journal 5(1):36-43.
Cociu A. I., 2010 Tillage system effects on input efficiency of winter wheat, corn and soybean in rotation. Romanian Agricultural Research 27:81-87.
Copec K., Filipovic D., Husnjak S., Kovacev I., Kosutic S., 2015 Effects of tillage systems on soil water content and yield in corn and winter wheat production. Plant, Soil and Environment 61(5):213-219.
Derpsch R., Franzluebbers A. J., Duiker S. W., Reicosky D. C., Koeller K., Sturny W. G., Sá J. C. M., Weiss K., 2014 Why do we need to standardize no-tillage research? Soil & Tillage Research 137:16–22.
Gott R. M., Sichocki D., Aquino L. A., Xavier F. O., Santos E. L. P. D., Aquino R. F. B. A., 2014 Sources and times of nitrogen application in the off season maize. Revista Brazileira de Milhoe Sorgo 13(1):24-34.
Filipović A., Vujević I., Ivanković S., Ćorić R., Jurcović D., Višnja V., 2016 The effect of soil selenium fertilization treatment on the content of some ions (Cd, Fe, Zn, and Se) and yield of two corn hybrid. 9th Congress of The Soil Science Society of Bosnia & Herzegovina 21:179-190.
Guș P., Rusu T., Bogdan I., 2004 Agrotehnică. Editura Risoprint, Cluj-Napoca, Romania.
Jitareanu G., Ailincai C., Bucur D., 2007 Soil fertility management in north-east Romania. Journal of Food, Agriculture and Environment 5(3/4):349.
Kumar R., Sing G., Walia S. S., 2000 Long term effect of manure and fertilizers on rice yield and soil fertility status in rice – wheat system. Environ Ecol 18:546–549.
Lal R., 1991 Soil management for sustainability. Soil and Water Conservation Soc., Ankeny. IA. Preface: XI –XII.
Lupu C., Pochișcanu S., Druțu C., Naie M., 2015 Influența îngrășămintelor cu azot asupra producției de porumb, în condițiile de la S.C.D.A. Secuieni, Analele I.N.C.D.A. Fundulea, vol. LXXXIII, pp. 131-137.
Mcvay K. A., Budde J. A., Fabrizzi K., Mikha M. M., Rice C. W., Schlege A. J., Thompson C., 2006 Management effects on soil physical properties in long-term tillage studies in Kansas. Soil Science Society of America Journal 70(2):434-438.
Marin I. D., Rusu T., Mihalache M., Ilie L., Nistor E., Bolohan C., 2015 Influence of soil tillage upon production and energy efficiency in weat and corn crops. AgroLife Scientific Journal 4(2):43-47.
Moraru P. I., Rusu T., 2011 Evolution of soil properties influenced by soil usage and soil tillage system. Journal of Food, Agriculture & Environment 9(2):710-713.
Moteva M., Kostadinov G., Spalevic V., Georgieva V., Tanaskovik V., Koleva N., 2017 Sweet corn conventional tillage vs. no-tillage in humid condition. Agriculture and Forestry 63(1):17-25.
Oncică (Moraru) M., Dobrinoiu C., Vișan R.V., Dănilă (Guidea) L. S., Oprea I., 2016 The influence of genotype and soil tillage system on forming production components for sweet corn under soil-climate condition specific to Romanian plain. Scientific Bulletin, USAMV, Bucharest, Series F, Biotechnologies, 20:69-74.
Reicosky D. C., 2015 Conservation tillage is not conservation agriculture. Journal of Soil and Water Conservation 70(5):103A-108A.
Rhoton F. E., 2000 Influence of time on soil response to no-till practices. Soil Science Society of America Journal 64(2):700-709.

Roldan A., Carabaca F., Elernandez M. L., Garcia C., Sanchez-Brito C., Velaschez M., Tiscareno M., 2003 No tillage, crop residue additions and legume cover cropping effects on soil quality characteristics under corn in Patzcuaro watershed (Mexico). Soil Tillage Research 72:65-73.
Romaneneckas K., Šarauskis E., Masilionyté L., Sakalauskas A., 2013 Impact of different tillage methods on silty loam luvisol water content in sugar beet crop. Journal of Environmental Protection 4:219-225.
Rusu T., Gus P., Bogdan I., Moraru P. I., Pop A. I., Clapa D., Pop L. I., 2009a Implications of minimum tillage systems on sustainability of agricultural production and soil conservation. Journal of Food, Agriculture & Environment 7(2):335-338.
Rusu T., Gus P., Bogdan I., Moraru P. I., Pop A., Pacurar I., Pop L. I., 2009b Effect of minimum tillage systems on the soil conservation and sustainability of agricultural production. Tarım Makinaları Bilimi Dergisi 5(3):241-245.
Rusu T., Moraru P. I., Bogdan I., Pop A. I., Sopterean M. L., 2011 Effect of soil tillage system upon the soil properties, weed control, quality and quantity yield in some arable crops. World Academy of Science, Engineering and Technology 59:756-759.
Subbulakshmi S., Harisudan C., Saravanan N., Subbian P., 2009 Conservation tillage–An ecofriendly management practices for agriculture. Research Journal of Agriculture and Biological Sciences 5(6):1098-110.
Wang J. H., Geng L. H., Zhang C. M., 2012 Research on the weak signal detecting technique for crop water stress based on wavelet denoising. In: Advanced research on engineering materials, energy, management and control. Pts 1 and 2, pp. 424–425, 966–970.

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