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Original Article

The Influence of Tillage Systems and Foliar Fertilization on Asimilation and Yield in Maize Crop in the Transilvanian Field

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Abstract

Conservation agriculture comes with a set of principles to implementation and development of sustainable technologies with the aim of retaining sufficient quantities of vegetal remains on the soil surface for soil protection against erosion, water evaporation and surface leakage, for better use of rainfall and improve the physical, chemical and biological soil properties associated with long-term stable yeld. The research was aimed at determining the influence of new foliar fertilizers and soil tillage systems on assimilation .The research method used for assimilation and the physiological parameters determination of Turda 332 maize hybrid was non-destructive (the leaves have not been detached from the plant) and was based on the use of a CIRAS-3 leaf gas analyzer which simultaneously determines several physiological and environmental indicators. The highest values of assimilation were recorded in conservative tillage systems being between 37.9 şi 42.9 $\mu molm^{-2}s^{-1}$ CO_2 and the fertilized variant of the Haifa foliar product 40.74 $\mu molm^{-2}s^{-1}$ CO_2.

Keywords: *conservative agriculture, assimilation, maize, foliar fertilizers, yield.*

1. Introduction

Conservation agriculture comes with a set of principles to implementation and development of sustainable technologies with the aim of retaining sufficient quantities of vegetal remains on the soil surface for soil protection against erosion, water evaporation and surface leakage, for better use of rainfall and improve the physical, chemical and biological soil properties associated with long-term stable yeld [5, 7, 11].

All the features and the many uses make corn one of the most important crops with a high share in the agriculture of our country as well as in other countries [9].

The physiological processes that take place during the seed germination period and during the growth and development of maize plants have a particular influence on its yield and quality [4, 8]. Maize is a plant of the photosynthetic type C4, having two functional chloroplasts.

Chloroplasts in mesophilic cells and chloroplasts in perivascular cavity cells [2]. Plant and soil respiration are the main links in the carbon circuit through which the CO_2-bound plant returns to the atmosphere.

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Processes for the metabolism of the absorbed substances occurring in plants are the process by which solar energy is used to convert CO_2 from the atmosphere into the presence of water into organic compounds (dry matter) [6, 10].

In species with the metabolism of photosynthetic carbon C3, photosynthesis and growth at elevated carbon dioxide concentrations are sometimes reduced under nitrogen deficiency conditions.

In C4, there is often no increase in photosynthesis at high carbon dioxide and no down-regulation of photosynthesis.

However, because the low-sweat rate of high carbon dioxide is considered to be a primary cause of lower nitrogen uptake by the planes and because stomatal conductance is often reduced by the increase in carbon dioxide in C4 species, carbon dioxide high could also induce nitrogen deficiency in C4 species. In maize, nitrogen deficiency can reduce the leaf size without affecting the photosynthesis or nitrogen content per unit of leaf surface [3].

The main purpose of this paper is the influence of foliar fertilization on the assimilation and physiological parameters of Turda 332 maize hybrids on different soil systems.

Foliar fertilizers have the role of calibrating and forming the active growth intervals correlated with the productivity elements.

2. Material and Method

The research was carried out in 2018 at Turda Agricultural Research and Development Station (ARDS Turda) located in the Plain of Transylvania, on a faeologic verticular soil with neutral pH, clay texture, good and very good supply mobile and potassium phosphorus, soil humus content. The experience is bifactorial, and the area of an experimental parcel is 48 m^2. In the experience, maize sowing was done with the MT 6 - Maschio Gaspardo machine.

Sowing density was 65,000 plants/ha and the depth of seed incorporation was 5 cm. The rotation of crops is achieved in a 3-year soybean-wheat-maize system.The biological material was Turda 332 maize hybrid, created at ARDS Turda.

The experimental factors are:

Factor A - Soil works:

a_1 - classical system with turning the furrow (CS),

a_2 - minimum tillage, chisel variant (MTC),

a_3 - minimum tillage, disc harrow variant (MTD),

a_4 - no tillage, sowing directly (NT).

Factor B - foliar fertilizers:

b_1-unfertilized control;

b_2- Haifa 19:19:19 + Mg + ME (5 kg/ha);

b_3 - Folimax Oleo 12-04-24 + 2.0% MgO + 36.5% SO_3 + ME (1.5 kg/ha),

b_4 - Folimax Gold 27.0% N + 1.5% MgO + 02% B + 0.2% Cu + 0.02% Fe + 1.0% Mn + 0.02% Mo + 0.02% Zn (3 l/ha).

The first treatment was done in the 8-10 leaves phenophase, and the second treatment in 12-14 leaf fezophase.With the sowing, a NPK 27 : 13.5 : 0 complex fertilizer was also given (250 kg/ha), and a second fertilization was done in the 6-8 leaf phenophase, with a nitrogen fertilizer (120 kg/ha, to 33 kg/ha N) in all variants.

For weed control, treatments were carried out comprising combinations of herbicides Tender 1.2 l/ha, Merlin Flex 0.4 l/ha at 260 l/ha of water applied pre-emergence and vegetation used Starane 1.0 l/ha at 260 l/ha of water.

The obtained results were statistically processed by the variance analysis method and the lowest significant difference was determined - DL - (5%, 1% and 0.1%) (ANOVA, 2015).

The research method used to determine assimilation and physiological parameters in Turda 332 maize hybrid was non-destructive (the leaves were not detached from the plant) and was based on the use of a CIRAS-3 leaf gas analyzer that simultaneously determines several physiological indicators and the average: CO2 assimilation rate = net photosynthesis (A = μmol m-2s-1), total transfer line conduction (GS = mmol m-2s-1) μmol m-2s-1), reference CO_2 = μmol mol -1, absorption CO_2 = μmol mol -1, leaf temperature (Tleaf), and water efficiency in photosynthesis (WUE = μmol mol -1). The determinations were made under semicontrout conditions for normal CO_2 (390 μmolm-s-1), variable PAR (0 to 2000 μmolm-2 s-1).

Year 2018 was characterized as a warm year, but normal in terms of rainfall recorded at the weather station, but the data analyzed monthly and decadal shows that all the months of the growing season of the crops were warm or hot months except for the month July when we report average temperatures, as can be seen from the data presented in Fig. 1.

The precipitations in 2018 and shown in Fig. 2 indicate that the amount of rainfall varied monthly, with the absence of precipitation from important corn crops being recorded only during the production period.

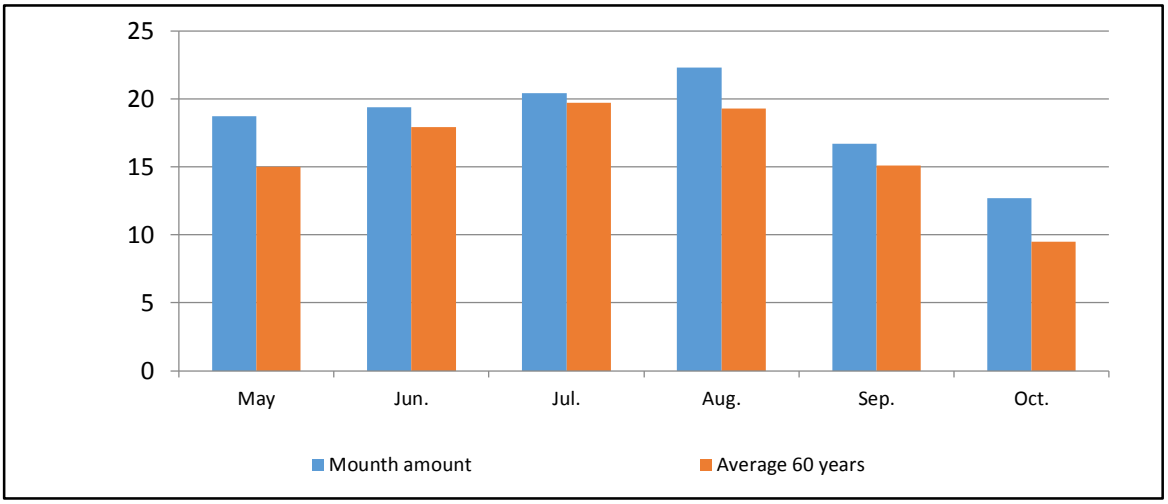

Figure 1. The thermal regime at SCDA Turda during May 1 -31 October 2018

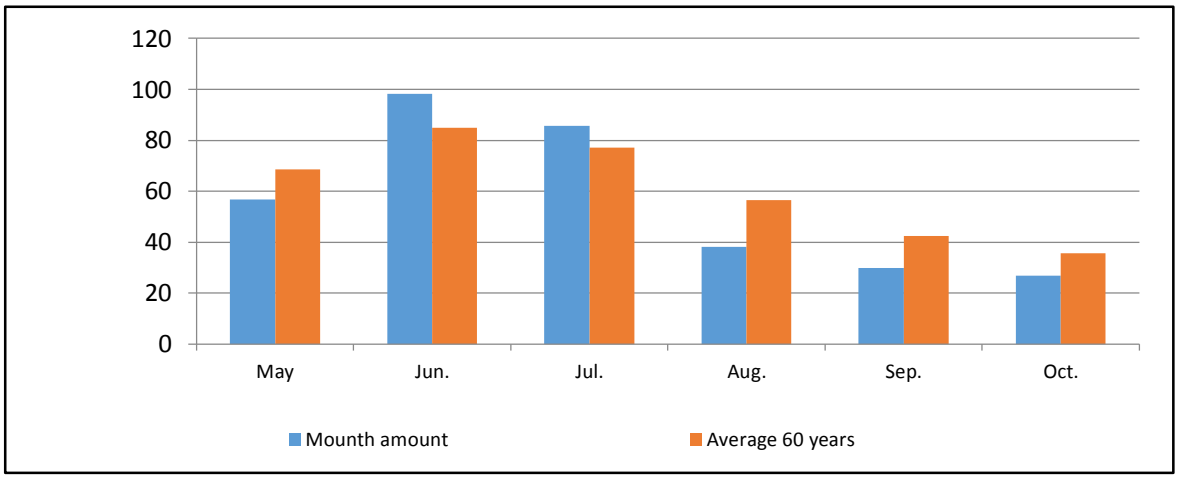

Figure 2. The pluviometric regime at SCDA Turda during 1 May -31 October 2018

3. Results and Discussion

In soil cultivation systems, we can see that the total assimilation average for Turda 332 maize hybrids in all soil processing systems, assimilation values ranged between 37.9 and 42.9 µmolm-2s-1 CO_2. Compared to the control variant, the conventional system, which recorded lower values, the values determined in the three systems were higher being statistically assured as very significant positive (Table 2).

The three variants of foliar fertilization influenced assimilation values, variant b2 - Haifa N: P foliar fertilizer: K- 19:19:19 + Mg + ME obtaining average values of 40.7 µmolm-2s-1 CO_2, the value being statistically assured as being very significant positive, and in the other variants where Folimax Oleo and Gold follicular fetishes were applied, the assimilation had no significant values compared to the unfertilized b1-control variant.

Similar data has also been obtained from the experiences of Bardas et al. (2015), whereby the average of the net photosynthesis in maize culture on the untreated variant was 26.0 µmol m-2s-1, and the treated variants obtained much higher values [1].

In maize hybrid Turda 332 assimilation and physiological parameters determined, there were higher values in the soil tillage system with the chisel, the disc and in the no tillage version the assimilation values oscillating between 37.5 and 45.3 µmolm-2s-1 CO_2 values statistically assured as very significant positive for the control variant.

After application of Haifa N: P: K- 19:19:19 + Mg + ME foliar fertilizer, the highest assimilation values were o btained at the soil tillage system with the chisel and the soil tillage system with the disc, the media the values obtained being statistically ensured as very significant positive and respectively significantly positive distict to the control variant.

The lowest value of assimilation was recorded in the "no tillage" system, with a statistically significantly negative mean compared to the control variant.

Table 1. Influence of systemic factor and foliar fertilizers on assimilation

Nr.	Tillage variant	Assimilation	%	Diff.	Signification
1	Classical system (CS) (control variant)	35,13	100,00	0,00	CV.
	Minimum tillage (MTC)	42,85	122,0	7,72	***
	Minimum tillage (MTD)	37,90	107,9	2,78	***
	No tillage (NT)	38,81	110,5	3,68	***
	DL (p 5%) 0.70; DL (p 1%) 1.06; DL (p 0.1%) 1.70;				
Nr.	Fertilization variant	Asimilation	%	Diff.	Signification
2	Basic fertilization (control variant)	38,32	100,0	0,00	CV.
	CS+Haifa **23:7:23+ME**	40,74	106,3	2,23	***
	CS+ Folimax Oleo	38,75	98,5	-0,57	-
	CS+ Folimax Gold	38,88	98,8	-0,44	-
	DL (p 5%) 0.61; DL (p 1%) 0.83; DL (p 0.1%) 1.12;				

Table 2. Influence of foliar fertilization on physiological parameters in maize hybrid Turda 332

Physiological parameters	Systems Fertilization	a_1- plowing (c.v.)	a_2 –chisel	a_3 –disk harrow	a_4–no till
Net assimilation CO_2 (An-μmolm^{-2}s^{-1})	b_1 – Basic fertilization	30.2	40.3	37.5	45.3
Significance	Bf.	c.v.	***	***	***
Net assimilation CO_2 (An-μmolm^{-2}s^{-1})	b_2 – Bf.+Haifa	40.4	43.6	42.6	36.4
Significance		c.v.	***	**	000
Net assimilation CO_2 (An-μmolm^{-2}s^{-1})	b_3- Bf. +Folimax Oleo	34.5	42.4	35.7	38.3
Significance		c.v.	***	-	***
Net assimilation CO_2 (An-μmolm^{-2}s^{-1})	b_4- Bf.+Folimax Gold	35.4	45.1	35.8	35.1
Significance		c.v.	***	-	-
DL (p 5%)-1.27; DL (p 1%)-1.78; DL (p 0.1%)-2.51.					
CO_2 reference (μmolm-s^{-1})		390	390	390	390
Total conduction of the stomata to the transfer (GS-mmolm^{-2} s^{-1})	b_1 – Basic fertilization Bf.	77.6	53.2	33.7	34.9
	b_2 – Bf.+Haifa	73.4	59.9	45.2	20.4
	b_3- Bf.+Folimax Oleo	59.1	56.1	41.3	15.0
	b_4-FB+Folimax Gold	46.4	61.5	32.5	16.9
Evapotranspiration at the foliar level (E - mmolm^{-2}s^{-1})	b_1 – Fert de bază (FB)	2.34	1.64	1.10	1.17
	b_2 – Bf.+Haifa	2.28	1.79	1.44	0.70
	b_3- Bf.+Folimax Oleo	1.83	1.72	1.33	0.76
	b_4- Bf.+Folimax Gold	1.41	1.83	1.10	0.60
Active photosynthetic radiation (PARi) (0-2000) μmolm^{-2}s^{-1}	b_1 – Basic fertilization Bf.	905.7	967.7	989.4	1255.3
	b_2 – Bf.+Haifa	1032.2	1025.0	922.2	1090.9
	b_3- Bf.+Folimax Oleo	989.7	1151.9	1077.0	1076.0
	b_4- Bf.+Folimax Gold	1061.1	1111.2	1048.5	1169.0
Effectiveness of H2O use in photosynthesis (WUE) mmol CO_2 mol^{-1} H_2O.	b_1 -Basic fertilization Bf.	13.9	24.6	38.5	39.5
	b_2 – Bf.+Haifa	17.8	24.5	31.3	53.4
	b_3- Bf.+Folimax Oleo	19.1	24.7	26.9	50.3
	b_4- Bf.+Folimax Gold	26.4	25.3	37.1	59.7
Deficiency of water in the leaf (VPD – kPa).	b_1 – Basic fertilization Bf.	3.02	3.04	3.16	3.27
	b_2 – Bf.+Haifa	3.08	2.95	3.17	3.30
	b_3- Bf.+Folimax Oleo	3.05	3.03	3.17	3.35
	b_4- Bf.+Folimax Gold	2.99	2.95	3.21	3.40
Temperature of the leaf (T_L- ^oC).	b_1 – Basic fertilization Bf.	28.4	28.2	28.2	28.4
	b_2 – Bf.+Haifa	28.6	28.0	28.2	28.3
	b_3- Bf.+Folimax Oleo	28.1	28.5	29.7	28.4
	b_4- Bf.+Folimax Gold	28.9	27.9	28.1	27.8

The application of Folimax Oleo foliar fertilizer had an influence on the assimilation of Turda 332 maize hybrid, registering much higher values for the soil tillage with the chisel and no tillage, having a statistically averaged statistically significant positive value compared to the control and at the soil tillage system with the disc, the values recorded being insignificant to the control variant.The use of Folimax Gold foliar fertilizer had an effect on assimilation, registering much higher values for soil tillage with the chisel, with the average difference being statistically significantly positive as compared to the control variant, the remaining variants not significantly different from the control variant.

Table 3. Influence of the soil tillage system factor on maize yield, Turda 2018

Tillage variant	Yield (kg/ha)	Difference (kg/ha)	Signification
Classical system (CS) (control variant)	9566	0	Mt.
Minimum tillage (MTC)	9472	-94	-
Minimum tillage (MTD)	9473	-93	-
No tillage (NT)	7374	-2192	000
LSD (p 5%) 221 LSD (p 1%) 405 LSD (p 0.1%) 898			

As can be seen in Table 3, corn reacts best to the classical soil tillage system where the highest yields were obtained; in the no tillage system the lowest production values were obtained with very significant negative differences compared to the control, the production difference recorded in the application of the MTC and MTD systems is not statistically assured against the control variant. Similar data was also obtained from the experiments of Simon et al. (2009-2011), from which it follows that the difference between the classical soil tillage and the minimum tillage was only 18 kg/ha [12].

As can be seen in Table 4, by applying foliar fertilizers with a variable content of microelements, a production increase can be obtained with distinctly significant differences or very significant differences compared to the control variant to which no foliar fertilizer has been applied.

Table 4. Influence of foliar fertilization factor on maize production, Turda 2018

Fertilization variant	Yield (kg/ha)	Difference (kg/ha)	Signification
Control variant +Fertilizare de bază	8515	0	Mt.
Haifa +FB	9246	731	***
Folimax Oleo+FB	8847	332	*
Folimax Gold+FB	9276	761	***
LSD (p 5%) 300 LSD (p 1%) 421 LSD (p 0.1%) 594			

4. Conclusions

In Turda 332 maize hybrid, the application of different foliar fertilizers, which have different micro and macro elements in their composition, applied in different developmental phenophases, have a beneficial contribution to increasing assimilation, physiological parameters, and production.

The net assimilation (An) in 2018 for maize culture had higher values on fertilized variants increasing the total stomata conductance (Gs), internal active photosynthetic radiation (PARi), evapotranspiration (Evap), water efficiency (WUE) while leaf leaf depletion (VPD) decreased in all variants where foliar fertilizers were applied.

The obtained results show that the application of foliar fertilizers has the effect of increasing the intensity of photosynthesis and physiological parameters, leading to the increase of the leaf size, the taking of the vegetation period and the assimilation of carbohydrates, respectively the increase of the biomass.

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References

[1] Bărdaş M., M. Ignea, V. Deac, 2015, Research on Assimilation and Some Elements of Productivity Concerning Crops, Corn and Soybeans, Treated with the Foliar Fertilizer "Agro Argentum Forte" under the Agricultural Development Research at Station Turda" Bulletin USAMV series Agriculture 72(2), 347-351.

[2] Brageon J., 1973, J. Microsc. 16, 233–242.

[3] Bunce J.A., 2014, Corn Growth Response to Elevated CO_2 Varies with the Amount of Nitrogen Applied, American Journal of Plant Sciences, 5, 306-312.

[4] Burzo I., A. Dobrescu, 2005, Fiziologia Plantelor de Cultură Vol. II Fiziologia culturilor de câmp.

[5] Cociu A.I., 2011, Contribuţii la fundamentarea, realizarea şi dezvoltarea de tehnologii durabile şi economic viabile bazate pe agricultura conservativă, AN. I.N.C.D.A. FUNDULEA, LXXIX, nr. l.

[6] Körner C., J.A. Scheel, H. Bauer, 1979, Maximum leaf diffusive conductance in vascular plants. Photosynthetica 13, 45-82.

[7] Moraru P.I., T. Rusu, 2013a, Effect of different tillage systems on soil properties and production on wheat, maize and soybean crop. World Academy of Science, Engineering and Technology, Paris, France, 83, 162-165.

[8] Moraru P.I., T. Rusu, 2013b, No-tillage and minimum tillage systems with reduced energy consumption and soil conservation in the hilly areas of Romania. Journal of Food, Agriculture & Environment, Vol. 11, Issue 2, p. 1227-1231.

[9] Muntean L.S., S. Cernea, G. Morar, M.M. Duda, D.I. Vârban, S. Muntean, 2008, Fitotehnie, ED. AcademicPres, Cluj-Napoca.

[10] Rusu M., M. Marghitaş, T. Mihăiescu, I. Oroian, A. Dumitraş, 2005, Tratat de Agrochimie, Ed. Ceres, Bucureşti.

[11] Rusu, T., P.I. Moraru, 2015. Impact of climate change on crop land and technological recommendations for the main crops in Transylvanian Plain, Romania. Romanian Agricultural Research, no. 32, 103-111.

[12] Șimon A., L. Șopterean, A.M. Vălean, F. Chețan, C. Chețan, M. Ignea, F. Mureșanu, 2015, Influence of tehnological and biotic factors on some elements of the maize productions grown in the classical system and with minimum tillage at ARDS Turda, ProEnvironment 8 (22).