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PRELIMINARY RESULTS ON MAIZE BIOMASS UNDER THE INFLUENCE OF TILLAGE IN THE CONTEXT OF CLIMATE CHANGE

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Abstract

Environmental pollution has reached such an advanced stage that no measure can effectively stop the adverse effects shortly. The effort of many future generations is necessary globe wide to be able to restore within normal limits the damage that has been reached at present. Agriculture must contribute to these remedies by recycling plant residues, improving cultivation technologies to make them as environmentally friendly as possible, using biological pesticides and alternative methods of fighting harmful organisms, as well as redirecting farmers to choose new crops that can complete the range and diversify it to practice sustainable agriculture. The purpose of this research was to observe the quantity of maize biomass depending on the type of tillage by comparing specific conservative agriculture tillage with the classic soil tillage - plowing in drought and heat conditions of 2021-2022. The maximum values of green biomass (37.04 Mg ha^{-1}) and dry biomass (10.57 Mg ha^{-1}) were recorded in the scarified plot - L3, and the minimum values of 22.63 Mg ha^{-1} respectively 6.93 Mg ha^{-1}, in the control plot L1 - plowed.

Key words*: biomass, corn, conservative agriculture, plant residues, drought.*

INTRODUCTION

The biomass of plants used as fertilizer is closely related to the activity of microorganisms in the soil, the structure of the soil, and its fertility. The soil stores microorganisms that compose the living organic matter in it. Microorganisms are essential to plant growth and development due to their activities as a rich source of C, N, P, and S. They transform nutrients and degrade pesticides, they form a protective structure that prevents soil degradation and act as an indicator of soil fertility (Salinas-Garcia et al., 2002). When tillage, plant residues, and microorganisms interact in a calculated way, the benefits are seen not only on the crop but the entire ecosystem (Shukla et al., 2004).

Maize biomass is used in the bioethanol and biomaterials industry. The lignin present in its vegetable mass can be extracted for the development of advanced composites, polymer blends, carbon fibers, plastics, and nanomaterials. Maize biomass has antioxidant and antibacterial properties, UV protection effectiveness, and thermal stability (Grabovskyi et al., 2021; Camargos et al., 2019). Another use of corn biomass is its transformation into fiberboards (Theng et al., 2015). Used as a cover layer, dry biomass provides the soil with minerals such as calcium, magnesium, phosphorus, and potassium (Batista et al., 2009), improving at the same time soil organic carbon (Wilhelm et al., 2007).The efficiency of agriculture from an agricultural, economic, and environmental protection point of view means the use of crops seen from the angle of the primary production for human food, the secondary production for improving soil fertility and biodiversity by mixing plant residues with the soil, but also using it as a source of biomass for the energy sector.

Agriculture can be a comfortable source of raw materials used as biomass in the energy sector.

MATERIALS AND METHODS

The experience was carried out in 2022 in the Chiscani Experimental Field within A.R.D.S. Braila. The experiment was established on a vermic, phreatic, wet, moderately carbonated loess, clay-sandy, arable soil, with a clay content between 22.5-24.2% in the upper horizons, 29.2-21.2% in the transition horizons and 17.6-17.9 % at the base (at depths greater than 130 cm). This type of soil is well supplied in mobile phosphorus (P2O5), with values of 174-225 ppm in the upper horizons (0-20 cm) and middle, below 32 ppm in the transition horizon. The total nitrogen content is standard in the upper horizons, the soil reaction is dominantly alkaline with pH = 7.9-8.4, and the average humus content in the upper horizons is 2.4-3.1%, which decreases to 1.6% in the transition horizon (A/C).
The design of the experiment was distributed in three repetitions on five soil tillages: L1 - plowed (control), L2 - Paraplow, L3 - Scarified, L4 - Disc-Heavy and L5 - sown in stubble, without tillage Minim-Till.

RESULTS AND DISCUSSIONS

The year 2022 is considered very dry due to the lack of precipitation. In recent years, the only certainty about climate factors is that they are constantly changing and worsening. The agricultural year's monthly mean temperature of 12.4°C exceeded the multi-year monthly mean by 1.5°C. This atmospheric heat was all the more difficult for the crop plants to bear as the drought was also present, the precipitation deficit recorded compared to the multi-annual monthly average of 442 mm, was 178 mm, which means that the total precipitation in the agricultural year was 264 mm.
The application of land processing methods specific to the dry-farming work system that characterizes conservative agriculture has as an objective the performance of minimal soil works that allow the optimal growth of crops without harming the soil and the environment. In the presence of abiotic stress factors, the choice of soil work and crops to obtain the maximum yields is the object of study at the global level.

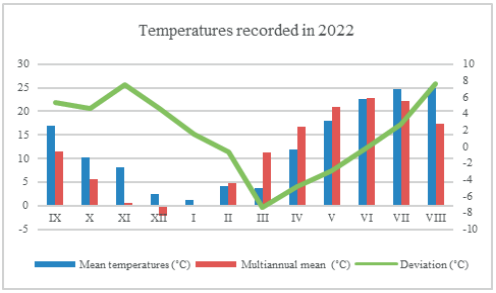

Figure 1. Mean temperatures recorded in 2021-2022 in Braila

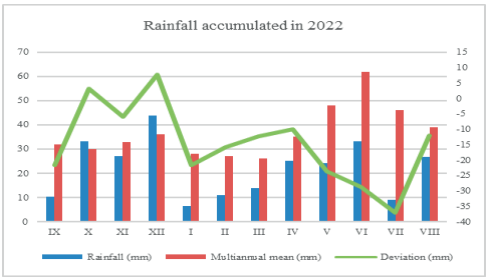

Figure 2. Rainfall accumulated in 2021-2022 in Braila

KyleW. Freeman et al. (2007) cited the authors Sadler et al. (2000) who conducted studies on the influences of soil type on productivity elements and biomass of crops under drought conditions. The corn crop, wheat, sunflower, and other crops often introduced in rotations in Romania are increasingly affected by drought and heat. Since the yields of corn crops obtained in 2022 in the study area were below 2 to/ha, the biomass was studied, and the possibility of its utilization as a source of renewable energy and fertilizer to reduce the damage caused by drought.

Figure 3. The effect of abiotic stress on plant development

Theng D. et al. (2015) state that the biomass of maize is composed of 60% stalks, 25% leaves, and 15% other parts of the plant, excluding cobs.
These proportions coincide with those obtained in our study in the Eastern area of Romania (Table 1).
The average green mass per plant and the average dry mass per plant were 532.4 g and 484.7 g, respectively 151.9 g and 142.5 g in the L3 - Scarified and L4 - Heavy-disc plots (Table 2). The control plot L1 - Plowing, recorded the minimum values, namely 325.3 g green mass and 99.7 g dry mass/plant.
The biomass increments obtained are superior to the L1 - control with values between 1.2 g and 207.2 g/plant (Table 2). Based on these results, the incapacity of the classic tillage can be deduced to contribute to the good development of the maize crop under climate stress conditions, both grain production and biomass production.
Maize biomass values according to tillage are statistically ensured and highlighted in Table 3.

Table 1. Corn plant's green mass divided into stems and leafs

Green Mass		
Tillage	**Stem (%)**	**Leafs (%)**
Plow (Control)	60.86	24.14
Paraplow	63.14	21.86
Scarification	60.06	24.94
Heavy-disc	59.01	25.99
Minim-Till	58.25	26.75

Table 2. The increase in green and dry biomass obtained, compared to the control

Tillage	The difference compared to Control	
	GM (g)	DM (g)
Plow (Control)	-	-
Paraplow	1.2	11.0
Scarification	207.2	52.2
Heavy-disc	159.5	42.8
Minim-Till	61.5	14.1

Table 3. Statistical assurance of the obtained biomass differences

Tillage	**GM (g)**	**Difference**	**Symbol**	**DM (g)**	**Difference**	**Symbol**
Plow (Control)	325.3	-	-	99.7	-	-
Paraplow	326.5	1.2	-	110.7	11.0	-
Scarification	532.4	207.2	***	151.9	52.2	**
Heavy-disc	484.7	159.5	***	142.5	42.8	**
Minim-Till	386.8	61.5	-	113.8	14.1	-
LSD5%=	*83.6*			*28.1*		
LSD 1%=	*121.7*			*40.9*		
LSD 0.1%=	*182.5*			*61.3*		

Maize plants lost between 21.5% and 25.12% moisture from stalks and 37.6% and 61.65% from leaves.
A loss of 61.65% was recorded in L2, and the minimum loss was in L3. Regarding the stems, the maximum and minimum losses were observed in L4 and L1, respectively.
A large amount of water stored in the leaves in the case of L2 and L1 may be a reaction to ensure the plant's survival.
To cope with stressors, plants redirect water into the leaves to carry out photosynthesis and thus survive. Regarding L3 and L4 tillage, the water was stored in the stem to develop the reproductive organs, namely the cobs.
The green mass per hectare obtained based on the studied soil tillage was between 22.63 Mg ha^{-1} and 37.04 Mg ha^{-1}, with L3 and L4 ranking first. It is due to the depth of tillage that allowed better penetration of the corn roots into the deep layers and efficient use of available water and nutrients.
The dry mass per hectare was in the range of 6.93-10.57 Mg ha^{-1}.

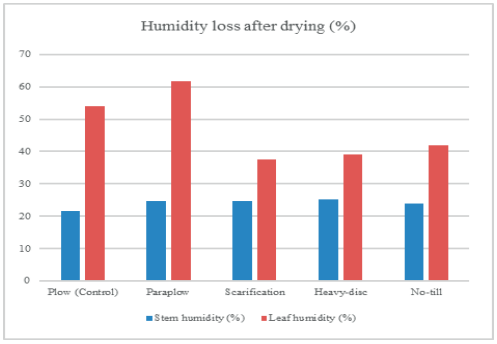

Figure 4. Humidity loss of corn plants after complete drying

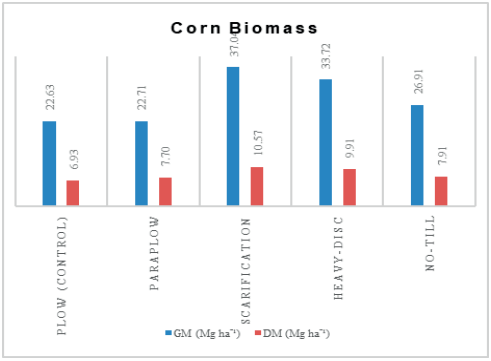

Figure 5. Green and dried biomass of corn plants based on soil tillage

Figure 6. The difference in plant height and drought tolerance of corn plants, based on soil tillage (From left to right: L1 - Plowed, L2 - Paraplowed, L3 - Scarified, L4 - Heavy-disk, L5 - Minim Till)

Based on these results, taking into account the poor yields obtained under such temperature and rainfall conditions, maize cultivation can be considered for the use of green mass as green manure and dry mass (plant residues) in restoring soil fertility, soil carbon and as a raw material in various industries (Wilhelm et al., 2007; Hooker et al., 2005; Igathinathane et al., 2006), including as a source of biomass for renewable energy, thus registering a major transformation of secondary production into primary production.

CONCLUSIONS

The year 2022 was both hot and dry, and the increase in temperatures associated with the lack of precipitation imposes conditions that are hard to tolerate for crop plants causing suffering even for drought-resistant ones.

The high yield losses of the corn crop in the current climatic conditions are a reason to consider cultivating this plant for the use of biomass in various industrial branches and agronomic purposes.

The soil tillages of conservation agriculture, L3 - scarification and L4 – heavy-disk, contributed to the valorization of water and nutrients from deep soil depths, thus allowing good development of the maize plants and helping them tolerate the stress factors of the experimental year.

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