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PRODUCTION OF STRAW CEREALS UNDER THE INFLUENCE OF SOIL TILLAGE AND CLIMATE CONDITIONS, FROM SOUTH-EAST ROMANIA

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Abstract

Supplying the necessary food to the global population is threatened by how pollution affects food quality. Pollution manifests itself through the defective management of natural resources and the instability of environmental factors. These variations in temperatures and rainfall become problematic with each passing year. The worrisome predictions of climate change and particularly its repercussions on agriculture and the survival of mankind challenge researchers to constantly look for solutions regarding crop technology and the type of cultivated plants so that the impact on the environment is minimum while obtaining rich and qualitative harvests. This paper aims to observe and analyze the adaptability of straw cereal species to the types of tillage that characterize the dry-farming work system under different conditions of abiotic stress recorded between 2019-2022. The triticale crop showed positive yield increases compared to the control tillage in all specific conservation agriculture tillages during the three-year study, while the rye crop showed instability regarding yields.

Key words*: staw cereals, adaptability, conservative agriculture, yields.*

INTRODUCTION

Adapting soil tillage and crop plants to areas where classic, intensive agriculture caused over the years, the decrease of soil fertility and its degradation is of enormous agronomic and economic importance. Cereals represent the basis of the agri-food industry that supplies food to the global population. Therefore it is vital to obtain prosperous and valuable production, especially since these plants are subject to environmental pollution and its consequences.

Fluctuations in environmental factors caused by pollution, especially the lack of precipitation (Ghatak et al., 2017), influence the achievement of production to cover food needs globally (Lamaoiu et al., 2018). As a result, plants need to be tolerant to water deficit, strong winds, extreme temperature variations in a short time, salinity, and soil infertility (Halford et al., 2015). The effects of various conservation tillages on the utilization of limited soil nutrients under climate stress have become the main focus of researchers and primary concerns of farmers globally. Long-term studies on the productivity of crops established on land processed by the methods that are the basis of conservative agriculture take place at NARDI Fundulea. The principles underlying conservative agriculture rely on the importance of protecting the soil against erosion and subsidence (Chamen et al., 1992), conserving water inside the soil, and reducing costs with technology (Van den Putte et al., 2010; Bacenetti et al., 2015; Zentner et al., 2002). The response of plants to the instability of abiotic factors manifests itself through physical, morphological, and metabolic changes to adapt themselves and tolerate the damage caused by stress (Havrlentova et al., 2021; Basu et al., 2016). We can assist plants in the fight against harsh climatic conditions by choosing the tillage for the root system to develop optimally and have access to nutrients from great soil depths. Deep tillage loosens the soil and allows roots to reach nutrients and water stored inside the soil (Bengough et al., 2011). Doing so, the plants consume water and do not allow it to evaporate, which results in the absorption of more radiation and, as a result, a good development of the aerial organs, which contributes to obtaining rich harvests without compromising the quality of the seeds (Halford et al., 2015; Unkovich et al., 2023). Another considerable factor for increasing the tolerance to climate stress is the close connection between the root system and the microorganisms that live inside the soil (Hartman and Tringe, 2019), which also depends on the quality and method of soil processing.

MATERIALS AND METHODS

The experience placed in the Chiscani Experimental Field, within ARDS Braila, was conducted during 2019-2022. From a geomorphological point of view, the mentioned perimeter represents a relatively flat area with an absolute altitude between 14-15 m. The soil is chernozem type, vermic subtype, with moderate-carbonate variety, loamy texture, formed on loess deposits with a predominantly loamy texture up to 1 m depth, and sandy loam at greater depths. The calcium carbonate content varies between 4.5-5.0% in the upper horizons, and the humus supply is in the middle class (2.4-3.1%). Total nitrogen content is specific to the soil type, and mobile phosphorus is very good (74-225 ppm). The mobile potassium content is optimal in the 0 - 20 cm depth and good in the Am horizon. The soil reaction has pH values between 7.9-8.4 (dominantly alkaline).
The study was conducted on four straw crops: wheat (*Triticum aestivum* L.), barley (*Hordeum vulgare* L., 1753), rye (*Secale cereale* L., 1753), triticale (*Triticosecale* Muntzing, 1936), five tillage types, on three repetitions each (Figure 1): the classic tillage A1 - Plowing (control), and the tillages of conservative agriculture: A2 - Paraplow, A3 - Scarification, A4 - Heavy-disk and A5-Minim-till. The yields obtained according to the soil works, under the influence of the variability of climatic factors, were analyzed

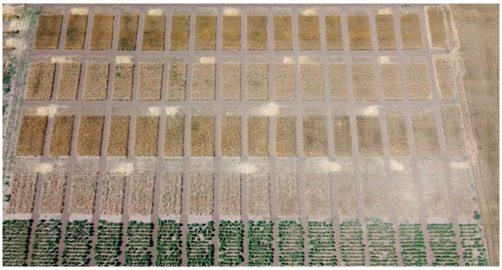

Figure 1. Field placement of cereal crops. From upward to downward: barley, wheat, rye, triticale. From left to right: A1- Plowing (control), A2 - Paraplowing, A3 - Scarification, A4 - Heavy disk, A5 - Minim-till

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RESULTS AND DISCUSSIONS

The analysis of average temperatures and accumulated precipitation in the study years (2019-2022) highlights the severity of the in-consistency of abiotic factors (Figures 2 and 3).

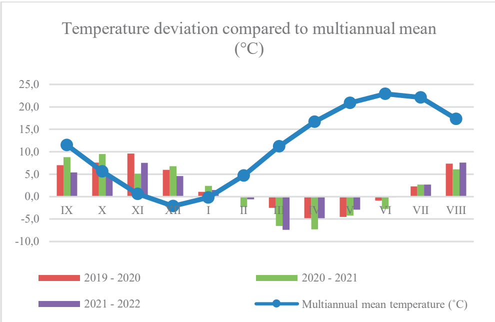

Figure 2. Mean temperatures recorded in the three years, in Braila - Romania

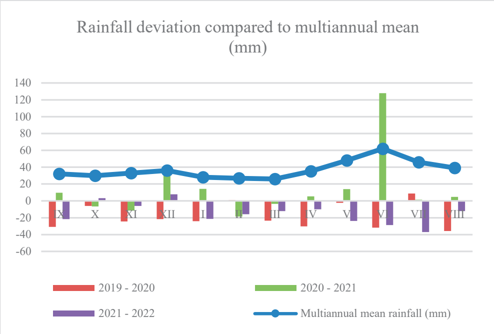

Figure 3. Rainfall recorded in the three years, in Braila - Romania

The 2019-2022 mean annual temperature was 1.8°C above the multi-annual mean of 10.9°C, with increases of 2.5°C in 2019, 1.5°C in 2020, and 1.5°C in 2021. Significant differences in temperature compared to the multi-annual mean, are observed between February and June. These negative temperatures prolong the dormancy period of straw crops, causing a delay in the onset of vegetation and an extension of the period until full maturity. One hypothesis of this extension of dormancy is that the plants become weaker, and the seeds produced suffer in terms of the quality of the constituent substances, directly affecting both food value and economic value.

Regarding the variation of temperatures over time, no significant differences are observed from year to year.

The effects of global warming can be seen through the amount of precipitation. Except for December and June of 2020-2021, rainfall was in deficit compared to the multi-annual monthly sum. The recorded precipitations over the three years were 77 mm below the multiannual sum of 442 mm. Although 2020 - 2021 recorded a deviation of +172 mm above the multi-annual sum, it was not enough to cover the deficit recorded in 2020 and 2022. Another worrying aspect is the variation of rainfall from year to year, namely 221 mm in 2020, 618 mm in 2021, and 264 mm in 2022. An anticipated hypothesis related to precipitation may be that it varies in opposite directions from one year to another, alternating a dry year with a rainy year. However, we must continue the studies to observe if this alternation persists, in which case we must choose crop plants that can tolerate better climatic stress.

The barley crop did not show enlarged differences in production compared to the control tillage-plowing in 2021, abundant in rainfall. In the dry year 2020, maximum increases were in A4 and A5 plots (663 kg/ha and 770 kg/ha). In 2022, the yield in A3 ranked first (4673 kg/ha). Although both agricultural years were poor in precipitation, the difference between yields is due to the increased temperatures of +2.5°C and +1.5°C. Considering the average yields over the three years of study, the type of tillages favorable for barley crops are a4 and A5, with yields of 4031 kg/ha and 4138 kg/ha compared to the control work (3368 kg/ha). In the case of sowing in stubble, the productions remained consistently superior to the control work, with minimal influences of environmental factors.

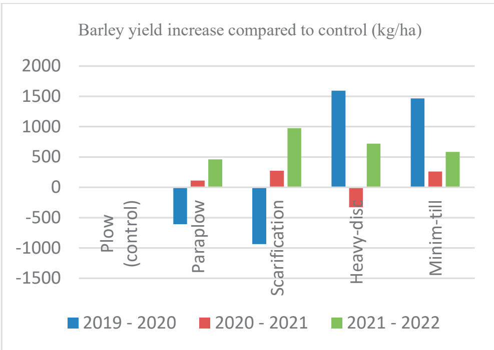

Figure 4. The difference in yield obtained in barley crop, compared to control tillage A1-Plowing

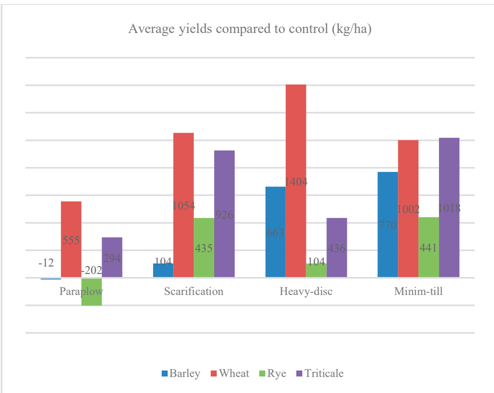

Figure 5. The difference in yield obtained in all crops, compared to control tillage A1-Plowing

Figure 6. Barley crop before harvesting

Figure 7. Wheat crop before harvesting

Tillage A2 (2846 kg/ha) and stubble sowing A5 (3293 kg/ha) contributed to productions below the control tillage A1 (3297 kg/ha), in the study years 2019-2022, for the wheat crop. In dry years, like the barley crop, tillage A4 helped to obtain the maximum yields compared to the other tillages of the dry-farming system, namely 3300 kg/ha in 2020 and 3500 kg/ha in 2022. Therefore we can presume that the root system of wheat does not have the power to penetrate the soil in the absence of humidity, developing at shallow depths. When rainfall is abundant and the soil stores water at great depths, the root system grows at greater depths, which is why in 2021, the yield obtained in the A3 plot was 4553 kg/ha.

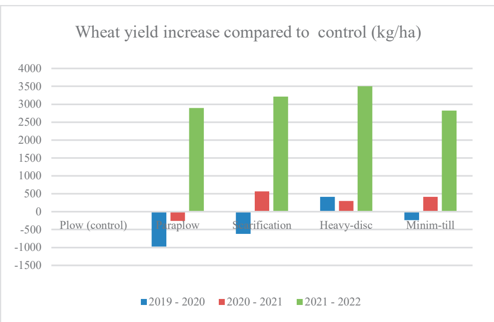

Figure 8. The difference in yield obtained in wheat crop, compared to control tillage A1-Plowing

The yields of the rye crop were superior to A1-control tillage in 2021, with abundant precipitation. Increases between 27 - 267 kg/ha were obtained, except for the heavy disc tillage from which we recorded a loss of 562 kg/ha. During the dry years, conservative tillages recorded unstable yields. In 2020, the maximum yields were obtained from the A4 and A5, while in 2022, they ranked below the control - A1.

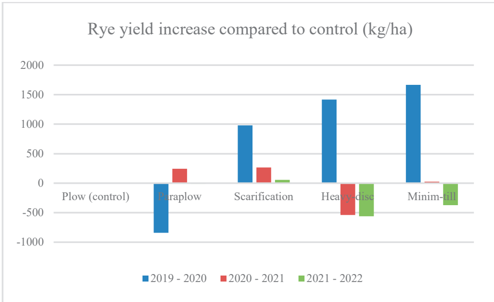

Figure 9. The difference in yield obtained in rye crop, compared to control tillage A1-Plowing

Figure 10. Triticale crop (left) and rye crop (right)

Triticale is a cereal with remarkable plasticity in conservative farming technologies. They produced superior harvests to the classical tillage A1-plowing, regardless of the total amount of precipitation. In A3 and A5 plots, triticale reached average productions of 4217 kg/ha and 4309 kg/ha in the studied period. Regarding the A5 (Minim-till), these results highlight the importance of the vegetal carpet in preventing the evaporation of water and its efficient use both by the root system of the plants and by the microorganisms that live in symbiosis with it.

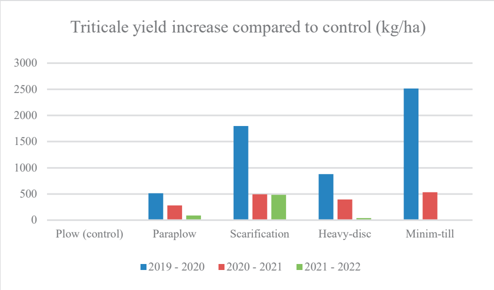

Figure 11. The difference in yield obtained in triticale crop, compared to control tillage A1-Plowing

The transition from classical to conservative agriculture is a long-term process that involves changing the quality and structure of the soil but also the accommodation of crops to these changes. Some species (triticale) adapt quickly, while others require several years to produce constant yields. Based on rye yields, it did not follow a pattern as triticale. Thus we can assume that rye responds more difficult to changes which is why further studies are necessary. In time, we must see whether the results will become conclusive and decisive for crops more sensitive to change and hold for cultures that adapt quickly. Another reason for the variation in yields obtained in 2020 and 2022 for the rye crop (both years were deficient in rainfall) may be the remaining soil water reserve from 2021, a year in which a redundancy of 176 mm was recorded.

CONCLUSIONS

The three studied years were hot, with temperatures above the multi-annual monthly average. Rainfall was in deficit in 2020 and 2022, which makes them very dry.

The triticale crop adapted to the specific tillages of the dry-farming system, registering positive increases in all three years of the study, regardless of the climatic conditions. Thus, the plasticity and adaptability of this plant to conservative farming techniques stand out.

The increases in yields between 460 and 977 kg/ha for barley and 2826-3500 kg/ha for wheat in 2022 are due to the accumulated rainfall in June 2021 (127.4 mm). The water was absorbed and stored by the soil. In autumn, at sowing time, the wheat and barley plants used it effectively, developing very well until the winter. At the beginning of spring, they resumed vegetation with high vigor and were able to tolerate the drought and heat of the next growing season.

ACKNOWLEDGEMENTS

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