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IMPACT OF CLIMATE CHANGE ON MAIZE PRODUCTION IN THE PEDOCLIMATIC CONDITIONS AT ARDS BRAILA

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Abstract

During the agricultural years 2020-2022 at SCDA Braila, experiments with maize hybrids have been placed in which the growth and development processes as well as the productivity of Felix, Iezer and F423 maize hybrids have been followed. In the climatic context of 2020, the growing cycle was staggered over a period of 159 days (10.04.2020-16.09.2020), during which time precipitation totalled 162.4 mm, accumulating a useful temperature of 3254°C. In 2021, the growing cycle was staggered over a period of 147 days (05.05.2021-29.09. 2021), during which period rainfall totalled 335.5 mm, accumulating a useful temperature of 3038.6°C, and under the conditions of this year, 2022, maize sown on 28.04.2022, covered 151 days to reach harvest maturity on 26.09.2022 under the conditions of accumulating a useful temperature required to cover the growth and development phenotypes of 3270°C. Yields recorded in the three crop years for the three hybrids ranged from 7.24 t/ha to 11.66 t/ha for hybrid Felix, from 7.48 t/ha to 9.95 t/ha for hybrid Iezer and from 8.96 t/ha to 11.80 t/ha for hybrid F423.

Key words*: maize, climatic conditions, precipitation, temperature, yields.*

INTRODUCTION

The therm "climate change" is defined differently by various parties, despite the fact that the backdrop is the same. The Intergovernmental Panel on Climate Change (IPCC, 2007) defines climate change as a change in the state of the climate that is identifiable by changes in the mean and/or variability of its attributes and that continues for an extended period, generally decades or longer.

Climate change, as defined by the United Nations Framework Convention on Climate Change (UNFCCC), is a change in climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere, in addition to the natural climate variability observed over comparable time periods (IPCC, 2013).

The effects of climate change differ based on a region's level of development. For instance, suggests that rising temperatures and shifting precipitation rates will likely hinder the success of rain-fed agriculture in the majority of emerging nations (IPCC, 2021)

The importance of maize in global agri-food systems, both direct food consumption and indirect feed pathways for animal-sourced commodities, is growing. It is a versatile crop with multiple uses; although predominantly used as feed, it remains a significant food crop and has several non-food uses worldwide. In recent decades, global maize output has increased due to a mix of rising demand, yield gains, and land expansion. The global demand for maize will continue to increase. It is the top cereal in terms of production volume and is projected to become the most extensively cultivated crop in terms of area in the next decade (Erenstein et al., 2022).

In Romania, maize is one of the most significant crops. Around 2.5 million hectares were used to cultivate maize, which remained the most important crop with a share of 47.6% of the area cultivated for cereals and 30% of the overall area cultivated. Between 2011 to

2021, maize yields averaged 5,802 kg/ha. (Ghiorghe & Turek-Ravoveanu, 2022)
Aggressive temperatures in conditions of rainfall deficits during growth phases with maximum water requirements have a significant impact on yield components, regardless of the hybrid chosen, even when using high-performance crop technologies for maize cultivation, (Ion et al., 2013)
The objective of the present paper is to present the results obtained at 3 maize hybrids studied in the field conditions of the ARDS Braila, during three years (2020, 2021 and 2022) and evolution of temperatures and precipitations compared to the multiannual average of the region.

MATERIALS AND METHODS

The study was carried out during the period 2020-2022. The field experiment was located in Agricultural Research and Development Station (ARDS) Braila-Chiscani Experimental Center. Soil was a vermic chernozem with a medium humus content (2.4-3.1%) in the upper horizons and only 1.6% in the transition horizon.
The area where the tests were carried out is in the North Baragan region under the annual average climate for the period 1900-2014 is characterized by the following parameters: annual rainfall (agricultural year) - 445 mm, annual average air temperature - 11°C, potential evapotranspiration (after Thornthwaite) - 715 mm, and climatic deficit water annual average - 272 mm. It forecasts a decline in annual precipitation from 445 mm to 440 mm and an increase in annual average temperatures from 11°C to 11.3°C through 2025. (Visinescu et al., 2014).
The experimental material included three maize Hybrids: Felix, Iezer and F423, developed at the National Institute for Agricultural Research and Development in Fundulea. The experiment was located in the field according to the randomized blocks method, in three replications product after winter wheat predecessor. Soil tillage was done by plowing in autumn at a depth of 25 cm and seedbed preparation was carried out in spring at a depth of 8-10 cm.
The sowing was carried out on 10.04.2020, 05.05.2021 and 28.04.2022, respectively, at a depth of approximately 5-6 cm, at a density of 65,000 germinating grains/ha. The trial has been fertilized by complex fertilizers 200 kg/ha (NPK 18: 46: 0) before sowed and by urea 150 kg/ha, in vegetation. When suitable, pesticides were used to control weeds, diseases, and pests.
Harvesting was carried out in the second decade September 2020, and in the last decade of September 2021 and 2022.
At harvesting in each of the three years, determination and analyses were performed regarding the grain yield, yield per hectare adjusted to 14% moisture, and quality traits (hectoliter weight - kg/hl), thousands of grain weight). The hectoliter mass was determined using the Pfeuffer granulomas. The weight data of seed grains was determined using the ML-C1 automatic seed counter and the electronic balance, and then the average for each hybrid was calculated.
The variability presence in the hybrids was estimated by coefficient of variations (CV).

RESULTS AND DISCUSSIONS

Climatic aspects

The monthly precipitation, average temperatures and multiannual data for 2020, 2021 and 2022 are presented in Table 1.
Temperature and rainfall distribution throughout the growing season is the main climatic elements influencing maize growth and production. Analysis of these characteristics reveals that during the three years of study (2020-2022), monthly average temperatures recorded positive deviations from the multi-year monthly average in most months, and the amount and distribution of precipitation vary between years.
The year 2020 was characterized as an unfavorable year for maize with severe drought stress in April, June and August. Precipitation in the April-September period was 185 mm, the deficit reaching -77 mm compared to the multiannual average. The rainfall deficiency was largely pronounced in May (-30.4 mm), June (-21.1 mm) and August (-35.9 mm). Regarding the thermal regime, between April

and September, the recorded values show that the average monthly temperatures were higher than the multiannual average, with positive deviations ranging from 0.7°C in April to 2.6°C in August and 3°C in September, respectively.

In 2021, the climatic conditions were considered as being favourable for maize crop, during vegetative period, rainfalls of 390 mm were recorded, with a pozitive difference of 128 mm from the multiannual average. The highest rainfall values were recorded in June 173.8 mm. The mean monthly temperatures were over the multiannual average in July (+1.9°C) and August (+1.4°C).

The year 2022 was characterized as an unfavorable year for maize crop with severe drought stress in May, June and July. For the growing period of maize the rainfall was significant less than multiannual average value, deficit reaching -112 mm. The largest positive deviations of the average monthly temperatures as compared to the multiannual average are registered in the months: June (+ 1.8°C), July (+1.9°C) and August (+2.9°C).

Based on the minimum and maximum temperatures recorded daily, the sum of the degrees of temperatures useful for plant development from sowing to harvesting. The sum temperatures for the studied agricultural years was as follows: in the year 2020 3254°C, in the year 2021 3038.6°C and 3270°C in the year 2022, respectively.

Table 1. Monthly and growing season temperature and precipitation at ARDS Braila 2020-2022

Months	Temperature (°C)				Precipitation (mm)			
	2020	2021	2022	Multiannual average	2020	2021	2022	Multiannual average
October	13.2	15.1	10.2	11.5	30.6	26.5	33.1	30
November	10.2	5.7	8.1	5.6	8.7	24.5	27.1	33
December	3.9	4.7	2.5	0.6	14.3	67.7	43.8	36
January	0.9	2.2	1.3	-2.1	3.8	41.2	6.5	28
February	4.6	2.4	4.1	-0.2	28.1	7.4	11.1	27
March	8.7	4.7	3.8	4.7	2.6	31.4	13.8	26
April	11.9	9.4	11.9	11.2	4.6	53.3	25.1	35
May	16.4	16.7	18	16.7	45.8	75.8	24.3	48
June	22	20.2	22.7	20.9	36.9	173.8	33.3	62
July	24.4	24.8	24.8	22.9	54.8	40.4	8.9	46
August	24.6	23.4	24.9	22	3.1	36.7	26.9	39
September	20.3	16.9	17.9	17.3	39.5	10.4	31.8	32
Average/Total	**13.4**	**12.2**	**12.5**	**10.9**	**273**	**589**	**286**	**442**

Source: Meteorological Stations Braila

Grain yield

The studied hybrids have recorded relatively highest yields, the average amount being 9,564 kg/ha in the research period of three years (Table 2) but looking at the average yield of the maize genotypes investigated over the course of three years, there are evident variations. This indicates that the year had a major impact on the grain yield in each of the three years.

Grain yield is one of the complex traits regulated by multiple genotypic and environmental factors interacting with one another. Few yield components are less complex, more heritable, and less responsive to environmental changes (Kashiani & Saleh, 2010).

Of the three years of study, the most favorable for maize was 2021 (11137 kg/ha), followed by 2020 (9650 kg/ha), and the least in 2022 (7907 kg/ha).

In 2020, rainfall during the growing season of maize recorded a deficit of 77 mm, and in 2022, the deficit recorded was 112 mm, which is reflected in the yields obtained. In contrast, in 2021, the rainfall distribution was irregular, but overall it was a favorable year for maize cultivation.

The highest yield in 2020 was achieved by the hybrid F423 (10230 kg/ha), and in 2021 was achieved by the hybrids F423 (11800 kg/ha) and Felix (11660 kg/ha). In the year 2022, the average grain yield was 7907 kg/ha and the highest yield was 8996 kg/ha for the hybrid F423.

The highest yield stability was registered at hybrid Iezer, with a coefficient of variation (CV%) less than 10%, and a respective value of 3.64%, but this hybrid in all three years has achieved small yields.

Table 2. The grain yield (kg/ha) and maize hybrids stability (%)

No.	Genotype	Yield (kg/ha)			Average 2020-2022	C.V. %
		2020	2021	2022		
1	Felix	9360	11660	7240	9420	23.47
2	Iezer	9360	9950	7484	8931	3.64
3	F423	10230	11800	8996	10342	13.59
Average		9650	11137	7907	9564	13.57

Table 3. Thousand seed weight (g) and maize hybrids stability (%)

No.	Genotype	Thousand seed weight (g)			Average 2020-2022	C.V. %
		2020	2021	2022		
1	Felix	210.47	347.10	364.32	307.30	27.43
2	Iezer	252.32	333.40	359.10	314.94	13.14
3	F423	225.82	356.40	342.22	307.15	23.25
Average		229.54	345.63	355.21	309.79	21.27

Table 4. Hectolitre mass (kg/hl) and maize hybrids stability (%)

No.	Genotype	Hectolitre mass (kg/hl)			Average 2020-2022	C.V. %
		2020	2021	2022		
1	Felix	71.55	72.3	66.5	70.11	4.50
2	Iezer	68.55	71.43	65.30	68.43	2.11
3	F423	70.05	74.20	66.90	70.38	5.20
Average		70.05	72.64	66.23	69.64	3.93

Thousand seed weight (TSW)

Thousand seed weight is based on the characteristics of the hybrid, the growing conditions, the presence of limiting factors, and the moisture level of the grain.

The average TSW for the research period (2020, 2021, and 2022) was 309.79 g (Table 3), but there were no significant differences between the three hybrids.

The highest TSW values were recorded in 2022 (average 355.21 g) as follows: Felix (364.32g), Iezer (359.10 g), and F423 (342.22g). The lowest results were recorded in 2020, with an average of 229.54 g.

For this trait, genotype Iezer had the best stability (coefficient of variation was 13.14%) and the hybrid Felix registeres the highest variability (coefficient of variation of 27.43%).

Hectolitre mass

The average hectolitre mass for the researching period (2020-2022) have been 69.64 kg/hl (Table 4). On average, significantly higher values were recorded for hybrid F423 (70.38 kg/hl) and hybrid Felix (70.11 kg/hl).

The highest average value of the hectolitre mass was registered in 2021, with 72.64 kg/hl and the lowest in 2022, with 66.23 kg/hl, these results are influenced by the hydroclimatic conditions of the study years.

Lower values of the variation coefficient for the average hectolitre mass ranged from 2.11% (Iezer) to 5.23% (F423), emphasizing the excellent stability of this characteristic.

CONCLUSIONS

The average yield for all examined hybrids was 9564 kg/ha, the average thousand seed weight was 309.79 g and the average hectolitre mass was 69.64 kg/hl.

On average during the period of the study (2020-2022), the highest grain yield was obtained from F423 - 10342 kg/ha, followed by Felix - 9420 kg/ha and the lowest - from Iezer - 8931 kg/ha. The highest weight of thousand seed weight was obtained from Iezer- 314.94 g and hectolitre mass was registered for F423 hybrid- 70.38 kg/hl.

Thus, following the study, it can be appreciated that the three maize hybrids are suitable for the area of influence of the ARDS Braila, with the F423 hybrid for high yields and the Iezer hybrid for stability under different climatic conditions in the three years of cultivation.

Despite 2021 being a favorable year for maize crop in the area where the field experiment was conducted, the studied maize hybrids responded differently to growing conditions. In order for maize growers in Romania to achieve high and profitable yields under drought conditions, it is imperative that they select the correct maize hybrid based on the region's specific growing, hydroclimatic conditions and technological conditions.

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