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PRODUCTIVITY OF SUNFLOWER HYBRIDS GROWN UNDER EXTREME DROUGHT IN TWO DIFFERENT ECOLOGICAL REGIONS

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Abstract. *The experiment was set up using a block method in 4 replications after a wheat predecessor in the fields of two different ecological regions – Thrace (Plovdiv region) and Dobrudja (Dobrich region), Bulgaria. Six sunflower hybrids were studied – P64LP170, breeded in Corteva, USA as a standart, and Bulgarian hybrids Dalena, Deveda, Enigma, Krasela and Sunny, breeded at the Dobruja Agricultural Institute - General Toshevo. Seed yield (SY), kg/da was determined by indirect method from a harvested plot. Both harvest years were characterized by extremely low rainfall during the critical periods of sunflower vegetation, accompanied by higher average monthly temperatures than the climatic norm. This is typical for both agro-ecological regions - Thrace and Dobrudzha and had an extremely negative impact on the productivity of all tested sunflower hybrids. In the first year of the study, the seed yield of all studied hybrids was higher in the Dobrich region. In both regions, the highest yields were recorded for the control hybrid P64LP170 and the lowest seed yield was recorded for the Krasela. In the second year of the study, the seed yield of all studied hybrids in both agro-ecological regions was lower than in the first. Comparing the two regions, the yield in the Plovdiv region was higher than that in Dobruja. In the Plovdiv region, the highest yields were recorded for the Dalena CLP hybrid, and in the Dobrich region for the control hybrid P64LP170. The lowest seed yield was recorded for the Krasela hybrid in Plovdiv, and in Dobrich for the Dalena CLP hybrid, which makes the interaction between the two factors non significant in the second year.*

Keywords*: sunflower, hybrids, drought, yield*

INTRODUCTION

Sunflower (*Helianthus annuus* L.) is the most important oilseed crop in the temperate climate zone. The largest producers of sunflower in the world are Russia with 7.20 million ha and Ukraine with 5.80 million ha. These two countries provide more than 50% of the total world production of sunflower. Other significant sunflower producers are the European Union with 4.24 million ha and Argentina with 1.82 million ha (JOCIĆ et al., 2015). In Europe, the Balkan countries are some of the largest producers of sunflower, especially Romania (VRÂNCEANU, 2000), Bulgaria (GEORGIEV et al., 2019), Turkey (KAYA et al., 2012) and Serbia (SKORIC, 2012). Sunflower is grown worldwide in temperate, subtropical and tropical climates in a very wide range of agroecological environments (DEBAEKE et al., 2021). In arid and semi-arid conditions, sunflower is grown under irrigation, while in temperate regions it is mainly a rainfed crop during the growing season (GARCÍA-VILA et al., 2012). In France, for example, where only 5% of the sunflower area receives supplementary irrigation, it requires only limited amounts of water (~50 mm) with good efficiency (CHAMPOLIVIER et al., 2011). As a warm-climate crop with medium water requirements, it can add diversity to crop rotations in arid regions (JOHNSTON et al., 2002). Because it is moderately drought-tolerant, it often performs satisfactorily when other crops are dramatically affected (DEBAEKE and BERTRAND, 2008). With ongoing climate change, sunflower, as a spring-sown rainfed crop, may be more exposed to the direct effects of heat stress at flowering or during seed filling and to different and unpredictable drought scenarios during the growing season, both of which lead to yield

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reductions, reduced oil content and changes in fatty acid composition (GARAPOVA and KIRCHEV, 2021; MORIONDO and BINDI, 2007; MORIONDO et al., 2011; DONATELLI et al., 2015; ANDRIANASOLO et al., 2016).

MATERIAL AND METHODS

The experiment was set up using a block method in 4 replications after a wheat predecessor in the fields of two different ecological regions – Thrace (Plovdiv region) and Dobrudja (Dobrich region), Bulgaria. Six sunflower hybrids were studied – P64LP170, breeded in Corteva, USA as a standart, and Bulgarian hybrids Dalena, Deveda, Enigma, Krasela and Sunny, breeded at the Dobruja Agricultural Institute - General Toshevo. Seed yield (SY), kg/da was determined by indirect method (ZAPRYANOV and MARINKOV, 1978) from a harvested plot using the formula:

SY = m.n/1000

where,

m – mass of seeds in a head (pseudanthium), g

n – number of plants/ da

There was used two-way ANOVA to define statistically significant differences between the hybrids and regions.

In the first year, in the conditions of Thrace, the first three months of the sunflower vegetation (April, May and June) have rainfall close to the climatic norm. This coincides in time with the phenophases until the beginning of flowering. The good moisture supply during this period led to good vegetative development of the plants. The months of July and August, when the formation of the reproductive organs, maturation and accumulation of fats occur, are without rainfall of economic importance, which had an extremely unfavourable effect on the magnitude of the seed and oil yield.

In terms of temperature, all months are 1-4 degrees higher than the average multi-year temperature, which, especially in the months without rainfall, further affected the development of the crop.

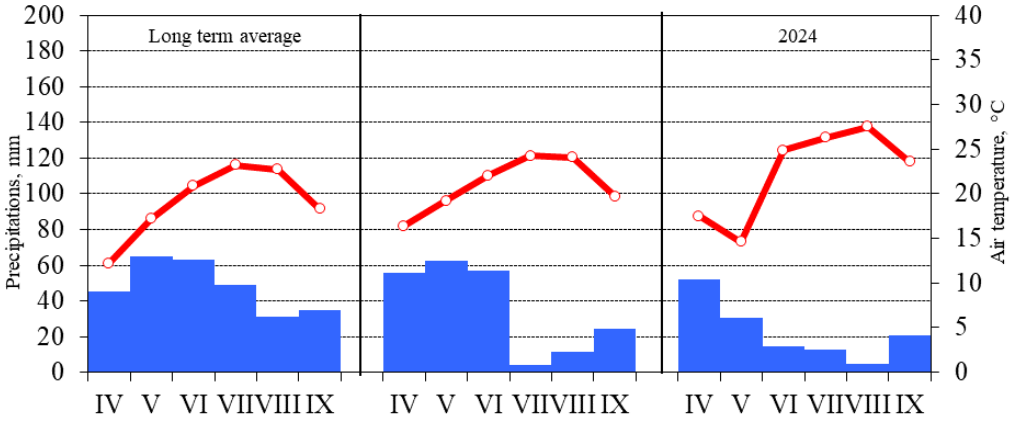

Figure 1. Climatogram in Thrace

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In the second harvest year, precipitation in April was about seven mm higher than the climatic norm, which in turn led to the later sowing of sunflower. In all other months of the crop's vegetation (May, June, July, August and September), precipitation was many times lower than the climatic norm, with the most drastic difference in June - 48.4 mm. The huge lack of moisture throughout the entire sunflower vegetation had an extremely adverse effect on its overall development. In terms of temperature, in 2024, all months of the crop's development were 2-5 °C higher than the average multi-year temperature, with the largest difference in August - 5.3 degrees. The combination of high temperatures and insufficient precipitation throughout the entire vegetative period had an extremely adverse effect on the crop in every aspect.

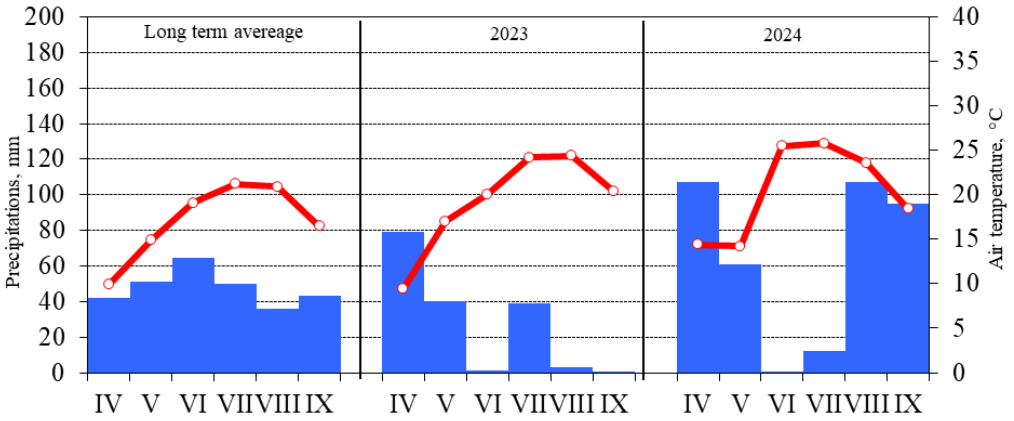

Figure 2. Climatogram in Dobrudja

In Dobruja, the first year, the autumn-winter moisture reserve was almost 3 times less than in the previous few years and 2 times less than the average perennial for 70 years ago. There was almost no snow during the period, and the little that fell did not even make a small snow cover. All this was combined with the very small in quantity and quality of vegetation precipitation, which was only 162.4 mm/m2, two times less than the average perennial. Only the months of April and May had normal precipitation. This contributed to the good development of the vegetative organs, as it coincides with the phases until the beginning of budding. From here on, they were very, very scarce and in quantity without economic significance. An extremely unfavorable year in terms of precipitation. This naturally had an adverse effect on the development of the reproductive organs of the sunflower and it could not show its potential.

In the second year of the study, the autumn-winter stock was 221.0 mm, which is very close to the average perennial for 71 years ago. Vegetation precipitation was relatively more than last year's and compared to the average perennial. As an absolute value, they are 373.8 mm, but the useful amounts fell only at the beginning of the vegetation period - April and May. The following three months, there was almost no precipitation of economic importance. In August, it can be seen that there were 107.4 mm, but these amounts fell at the very end of the month - the last 2-3 days and they did not positively affect the development of plants. On

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average, monthly temperatures were significantly above the average perennial, especially in the months of July, August and September. Due to the much cooler spring and precipitation in April, the vegetation of sunflower slowed down. This also negatively affected the productivity of sunflower, since its active vegetation coincided with a period of lack of precipitation, combined with high temperatures. In 2024, in addition to the fact that there was no precipitation, the daily temperatures were also very high. The heat, unlike other years, lasted for a very long time - several weeks. This had a very negative impact on the development of the sunflower, especially during flowering and grain filling. The average monthly temperatures were significantly above the multi-year average, especially in the months of June, July, August and September. This negatively affected the productivity of the sunflower, since its active vegetation coincided with a period of lack of precipitation, combined with high temperatures.

RESULTS AND DISCUSSIONS

In the first year of the study, the seed yield of all studied hybrids was higher in the Dobrich region (Table 1). The difference in yields between the two regions for each of the hybrids was different. For the standard P64LP170 the difference was the largest – 37 kg/da; for Dalena – 10 kg/da; for Deveda – 9 kg/da; for Enigma – 13 kg/da; for Krasela – 10 kg/da and for Sunny it was the smallest – 5 kg/da. The differences between the two regions were statistically significant, as were the differences between the individual hybrids. In both regions, the highest yields were recorded for the control hybrid P64LP170 – 257 kg/da in Thrace versus 294 kg/da in Dobruja, and the lowest seed yield was recorded for the Krasela hybrid – 195 kg/da in Plovdiv and in Dobrich – 205 kg/da. This unidirectional action of the two factors is established by the significant interaction of the factors “hybrid” and “region”.

Table 1

Seed yield, kg/da

Factor A (Hybrids)	Factor B (Regions)	2023	2024
P64LP170	Thrace	257	152
	Dobruja	294	140
Далена	Thrace	216	177
	Dobruja	226	121
Деведа	Thrace	211	144
	Dobruja	220	136
Енигма	Thrace	203	154
	Dobruja	216	127
Красела	Thrace	195	141
	Dobruja	205	134
Съни	Thrace	233	148
	Dobruja	238	140
ANOVA	*A*	*	*
	B	*	*
	A ×B	*	*ns*

* Significant effect at P<0.05, ns – non significant effect of the factor

In the second year of the study, the seed yield of all studied hybrids in both agro-ecological regions was lower than in the first. Comparing the two regions, the yield in the Plovdiv region was higher than that in Dobruja (Table 1). For the standard P64LP170 the

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difference was – 12 kg/da; for Dalena the difference was the largest – 56 kg/da; for Deveda – 8 kg/da; for Enigma – 27 kg/da; for Krasela it was the smallest – 7 kg/da and for Sunny it was – 8 kg/da. In the Plovdiv region, the highest yields were recorded for the Dalena CLP hybrid – 177 kg/da, and in the Dobrich region for the control hybrid P64LP170 - 140.1 kg/da. The lowest seed yield was recorded for the Krasela hybrid – 141.6 kg/da in Plovdiv, and in Dobrich for the Dalena CLP hybrid – 121.3 kg/da, which makes the interaction between the two factors non significant in the second year.

CONCLUSIONS

Both harvest years were characterized by extremely low rainfall during the critical periods of sunflower vegetation, accompanied by higher average monthly temperatures than the climatic norm. This is typical for both agro-ecological regions - Thrace and Dobrudzha and had an extremely negative impact on the productivity of all tested sunflower hybrids.

In the first year of the study, the seed yield of all studied hybrids was higher in the Dobrich region. In both regions, the highest yields were recorded for the control hybrid P64LP170 and the lowest seed yield was recorded for the Krasela.

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