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THE EFFECT OF IRRIGATION ON SOME YIELD PARAMETERS OF SEVERAL MAIZE HYBRIDS

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Abstract

Maize (*Zea mays*) is one of the most important arable crops worldwide, as well as in North Macedonia, due to its economic importance, nutritional value, and agronomic significance.
With the aim of selecting the most suitable hybrids for the climatic and soil conditions of the Polog region, a field experiment was conducted during the 2024 growing season using a randomized block design with five replications.
The study investigated several yield-related parameters of different maize hybrids, including: number of kernel rows per ear, number of kernels per row, total number of kernels per ear, ear weight, kernel weight per ear, cob weight, shelling percentage, and grain yield.
The hybrids included in the experiment originated from different seed-producing companies and belonged to various FAO maturity groups, namely: FAO 360 (GW3808), FAO 380 (GW9003), and FAO 400 (Kashmir).

Keywords: variant, hybrid, yield, shelling percentage, significance.

1. Introduction

Maize (*Zea mays* L.) belongs to the family of monocotyledonous plants (Poaceae). It originates from Central America, from where it spread to Europe and the rest of the world. Today, maize is one of the most important cereal crops globally, along with rice and wheat, and is cultivated over large areas due to its remarkable adaptability to diverse climatic and soil conditions.
Maize grains contain approximately 70–75% carbohydrates, 10% protein, around 5% oil, 1.5% minerals, and 2.5% cellulose. Maize also contains several essential amino acids such as lysine, tryptophan, and methionine, which significantly enhance the nutritional value of the grains.
The largest maize producers in the world are the United States, China, Brazil, the European Union (EU-28), and Argentina. Within the EU, maize is cultivated on an area exceeding 15 million hectares, of which about 60% (9.4 million ha) is grown for grain production and 40% (5.9 million ha) for silage. Maize is cultivated across a wide geographical range, from 58° northern latitude (Canada, northern Russia) to 40° southern latitude (Argentina, New Zealand).
Maize is also an important arable crop in North Macedonia, where in recent years, approximately 70,000–80,000 hectares have been cultivated annually. A primary interest for agriculture in North Macedonia is the regionalization of maize hybrids by positioning those with high adaptability to the specific climatic and soil conditions of each region, as well as selecting hybrids with high genetic yield potential.

2. Aim Of The Research

The aim of this study was to investigate the key factors determining the relatively low average maize yield at the national level, with particular emphasis on identifying maize hybrids with higher genetic potential and productivity under the agroecological conditions of the Polog region, as well as assessing the effect of irrigation on the analyzed parameters.
The regions with the highest maize production in North Macedonia are the Pelagonia and Polog regions. Since the demand for maize as a basic feed source for livestock is much higher than the domestic production, another important objective of this research was to identify hybrids that could help reduce the gap between demand and production.

3. Materials And Methods

The experimental material consisted of three maize hybrids: **GW3808 (FAO 360)**, **Kashmir (FAO 400)**, and **GW9003 (FAO 380)**.
The experimental design used was a **randomized block design** with **five replications**.

Analyzed Parameters

The following parameters were analyzed in the experiment:
1. Number of kernel rows per ear
2. Number of kernels per row
3. Total number of kernels per ear
4. Total ear weight
5. Kernel weight per ear
6. Cob weight
7. Shelling percentage
8. Thousand kernel weight (TKW)
9. Grain yield
10. Moisture content (%)

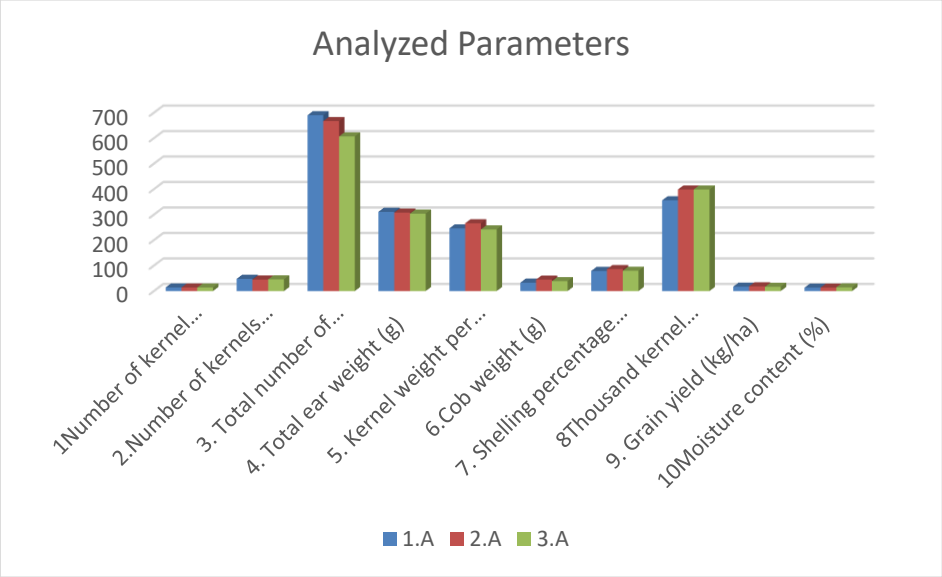
Types of Hybrids Included in the Experiment
1A – **GW3808** – with irrigation
2A – **GW9003** – with irrigation
3A – **Kashmir** – with irrigation
1B – **GW3808** – without irrigation
2B – **GW9003** – without irrigation
3B – **Kashmir** – without irrigation

4. Results And Discussion

The obtained results were analyzed separately for each parameter. For several parameters, significant differences were observed among the maize hybrids included in the experiment, while for others, although variations in the recorded values were present, these differences were not statistically significant.

Analyzed Parameters – Irrigated Variants

Parameter	1A – GW3808	2A – GW9003	3A – Kashmir
1. Number of kernel rows per ear	14.0	14.0	14.0
2. Number of kernels per row	48.0	45.2	46.0
3. Number of kernels per ear	690.4	667.2	607.2
4. Total ear weight (g)	311.0	308.0	304.0
5. Kernel weight per ear (g)	246.0	266.0	242.0
6. Cob weight (g)	33.0	45.0	39.0
7. Shelling percentage (%)	79.01	86.36	79.62
8. Thousand kernel weight (g)	356.3	398.7	398.6
9. Grain yield (kg/ha)	18.62	17.22	16.94
10. Moisture content (%)	13.4	13.4	14.3



Based on the obtained results for the analyzed parameters under irrigated conditions, the following observations were made:

For the **first parameter**, the **number of kernel rows per ear**, no differences were observed among the hybrids. Similarly, for the **number of kernels per row**, the differences were minimal and statistically insignificant.

Significant differences were recorded for the **number of kernels per ear**, particularly between hybrids **GW3808** and **GW9003** compared with **Kashmir**, indicating that the first two hybrids expressed higher kernel numbers per ear.

For the **total ear weight**, no statistically significant differences were found among the hybrids. However, for the **kernel weight per ear**, statistically significant differences were observed between **GW9003** and the other two hybrids (**GW3808** and **Kashmir**), suggesting a superior grain-filling capacity of GW9003 under irrigation.

The **cob weight** also showed significant differences among all three hybrids, indicating genetic variation in cob development.

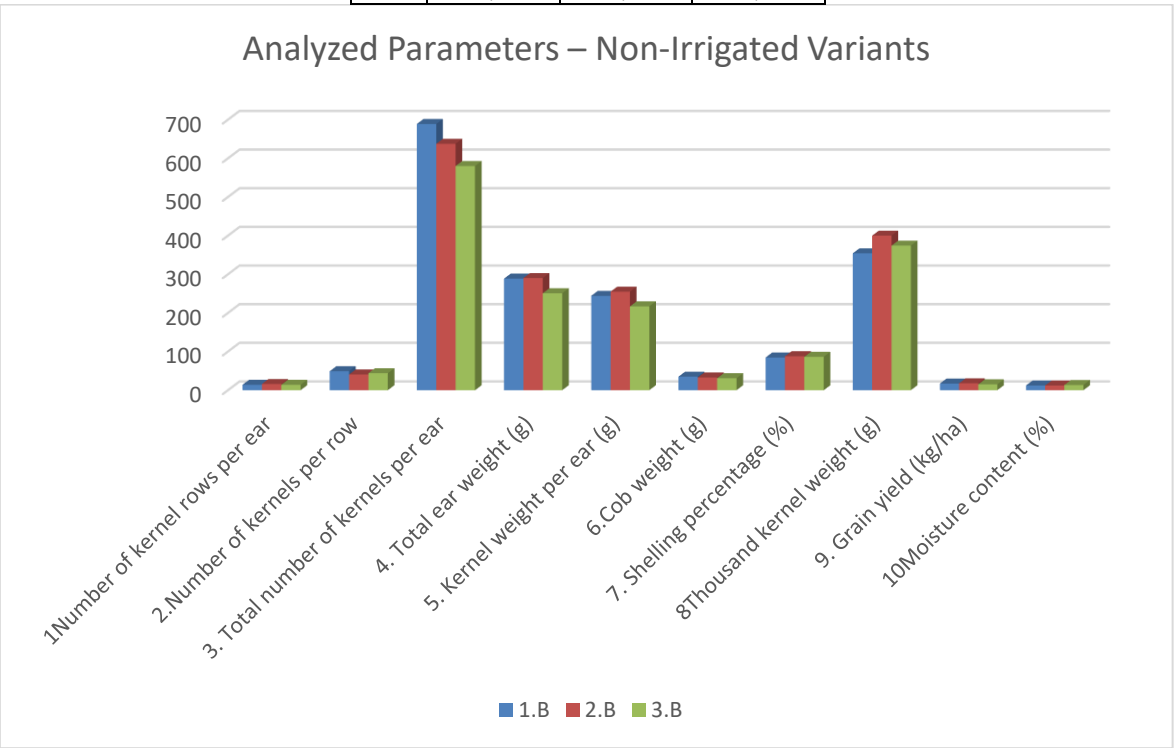
The **shelling percentage** exhibited statistically significant differences between **GW9003** and the other two hybrids, with GW9003 achieving a higher shelling efficiency.

Regarding the **thousand kernel weight (TKW)**, the highest values were recorded in **GW9003** and **Kashmir**, showing their potential for producing larger and heavier kernels.

As for the **grain yield**, one of the most important production parameters, statistically significant differences were found between **GW9003** and the other two hybrids (**GW3808** and **Kashmir**), confirming the superior productivity of GW9003 under irrigated conditions.
Finally, the **moisture content** at harvest showed no significant statistical differences and corresponded well with the length of the vegetation period for the studied hybrids.

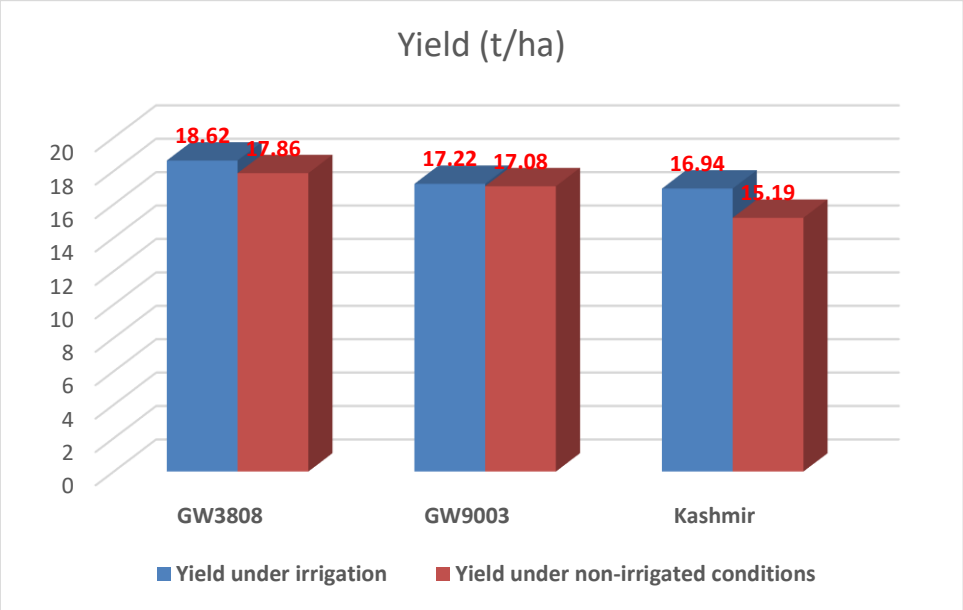
Analyzed Parameters – Non-Irrigated Variants

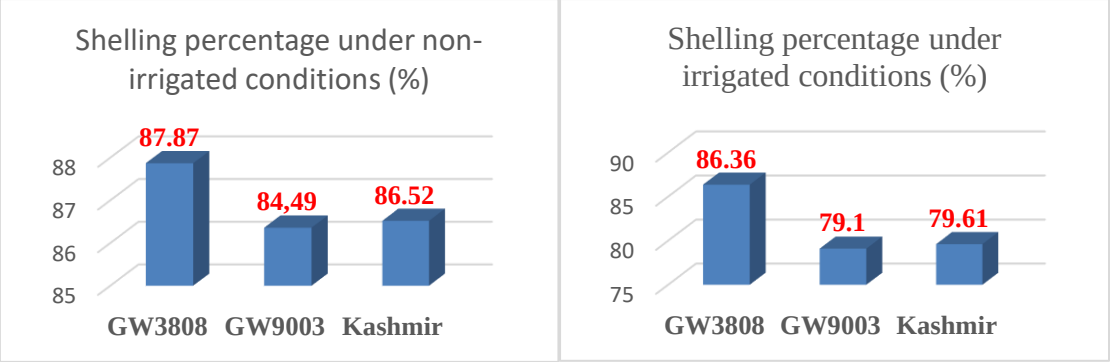
	1.B	2.B	3.B
1.	14,0	14,00	14,0
2.	49,2	40,8	44,0
3.	688,8	637,6	580,0
4.	288,8	290,2	250,8
5.	244,0	255,0	217,0
6.	35,0	33,0	31,0
7.	84,49	87,87	86,52
8.	354,2	399,9	374,1
9.	17,86	17,08	15,19
10.	12,2	12,1	13,3



Based on the results obtained for the analyzed parameters under the non-irrigated variant, certain differences were observed among the maize hybrids, although not all of them were statistically significant.
For the **number of rows per ear**, no notable differences were found among the hybrids, indicating that this trait is relatively stable and less affected by the absence of irrigation.
Regarding the **number of kernels per row**, differences were observed between hybrid **GW3808** and hybrids **GW9003** and **Kashmir**, with the latter two showing slightly higher values.

For the **total number of kernels per ear**, significant differences were found between hybrids **GW3808** and **GW9003** compared with **Kashmir**, suggesting that the Kashmir hybrid was more sensitive to water deficit.
Concerning the **total ear weight**, no statistically significant differences were recorded, although overall values were lower compared to the irrigated variant.
For the **grain weight per ear**, statistically significant differences were observed between hybrid **GW9003** and hybrids **GW3808** and **Kashmir**, highlighting the superior ability of GW9003 to maintain kernel filling under water stress conditions.
The **cob weight** did not show significant statistical differences among the hybrids, indicating a similar response to drought stress.
Likewise, the **grain-to-ear ratio (yield efficiency)** did not present significant differences among the hybrids, suggesting that the proportion between kernel mass and total ear mass remained relatively stable under non-irrigated conditions.
The **thousand kernel weight (TKW)** was higher in hybrids **GW9003** and **Kashmir** compared to **GW3808**, indicating the formation of larger and better-developed kernels even under limited water availability.
The **grain yield**, as the most important productive parameter, showed statistically significant differences between hybrid **GW9003** and **GW3808** compared with **Kashmir**, with the Kashmir hybrid producing notably lower yields.
The **moisture content** at harvest showed no statistically significant differences and corresponded with the length of the vegetation period for the hybrids studied.
In summary, the results for the non-irrigated variant indicate that hybrid **GW9003** demonstrated the best performance across most productive parameters, showing greater tolerance and efficiency under drought conditions. Hybrid **GW3808** exhibited moderate results, while **Kashmir** appeared more sensitive to water stress, resulting in lower yields.





5. Conclusions And Recommendations

Based on the results obtained for the analyzed parameters, the following conclusions and recommendations can be drawn:

- **Irrigation**, as an important agrotechnical measure, has a significant impact on increasing maize yield, depending on the length of the vegetation period of the hybrids. In hybrids with a shorter vegetation period, the effect of irrigation was less pronounced compared to hybrids with a longer vegetation period, where irrigation had a considerable influence.
- Although the hybrids included in the experiment belong to similar **FAO maturity groups**, under **irrigated conditions**, the earliest hybrid **GW3808 (FAO-360)** achieved a yield that was **8.13% higher** than **GW9003 (FAO-380)** and **9.9% higher** than **Kashmir (FAO-400)**.
- Under **non-irrigated conditions**, the yield difference of the earlier hybrid **GW3808 (FAO-360)** was **4.6% higher** than **GW9003 (FAO-380)** and **17.6% higher** than **Kashmir (FAO-400)**.
- The fact that yield differences are greater in the irrigated variant clearly indicates the **dependence of maize yield on irrigation**.
- The larger yield difference of the earlier hybrid under non-irrigated conditions also demonstrates the **relationship between yield and the length of the vegetation period**.

Based on the results obtained from this experiment, it can be concluded that for **profitable maize production under non-irrigated conditions**, it is recommended to cultivate **earlier-maturing hybrids**, as they show better adaptation to drought and limited water availability.
Furthermore, for achieving **higher and more stable maize productivity**, it is essential to **select hybrids with strong adaptability** to the **specific climatic and soil conditions** of each region.

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