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REDUCED IRRIGATION NORM AS A SUSTAINABLE AGROTECHNICAL MEASURE IN SWEET CORN PRODUCTION

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Abstract: The reduced norm of irrigation (50%) compared to the full (100%) and control was tested in three sweet corn hybrids (Enterprise, Union, and Sweet Nugget) in two sowing dates. Irrigation deficit did not significantly affect plant height, height to first ear or number of leaves in Enterprise and Union hybrids. Sweet Nugget had lower values of all parameters. ANOVA showed significant effects of irrigation, genotype, sowing date, and their interactions on most traits. The reduced rate enables 50% water savings without affecting plant morphology.

Keywords: Sweet corn, Reduced irrigation, Morphological characteristics, Hybrids, Date of sowing, Water saving

INTRODUCTION

Modern agricultural production faces increasingly pronounced challenges of climate change (Stojiljković et al., 2025), reduced availability of water resources (Ćosić et al., 2018; Moravčević et al., 2021), and the need to preserve the environment (Šević et al., 2025). Sweet corn (*Zea mays* L. var. *saccharat*a), a crop of high market value and high-water demand during critical stages of development, is a good choice for testing the feasibility of applying reduced irrigation norms without a significant decrease in grain yield and quality. The morphological characteristics of the plant - the height of the plant, the height of the plant to the first ear, and the number of leaves per plant directly reflect the degree of adaptation of genotypes to moisture deficit and are reliable indicators of photosynthetic potential and yield stability (Moteva et al., 2016; Nemeskéri, 2019). Numerous studies have shown that the full norm of irrigation significantly increases plant height (up to 22%) and the number of leaves (up to 45.3%) compared to production in conditions without watering (Moteva et al., 2016), while deficit irrigation or its absence leads to a decrease in these parameters (Nemeskéri, 2019; Ugur, 2015). In addition to the irrigation norm, the sowing date significantly affects sweet corn development (Shibzukhov et al., 2021; Tupajić et al., 2024). Earlier sowing dates (end of April) result in greater plant height due to a more favourable distribution of precipitation in May and June (Soare, 2019), whereas delaying sowing usually leads to a decrease in plant height and the position of the first ear (Ugur, 2015; Kilinç, 2021). Leaves, especially those around the ear, play an important role in yield formation (contribution of about 15% of total photosynthesis - Fujita

et al., 2001), and their surface, number and duration of green colour are directly related to the water and nitrogen regime (Zhou et al., 2019; Đalović et al., 2021).

The research aimed to examine the impact of a reduced irrigation rate (50% of the full rate) on the morphological characteristics of sweet corn in order to promote sustainable agriculture.

Working hypothesis: applying a reduced irrigation norm will not negatively affect the studied morphological features, enabling a 50% reduction in water consumption. This hypothesis represents an innovative step towards sustainable production in conditions of climate change.

MATERIAL AND METHODS

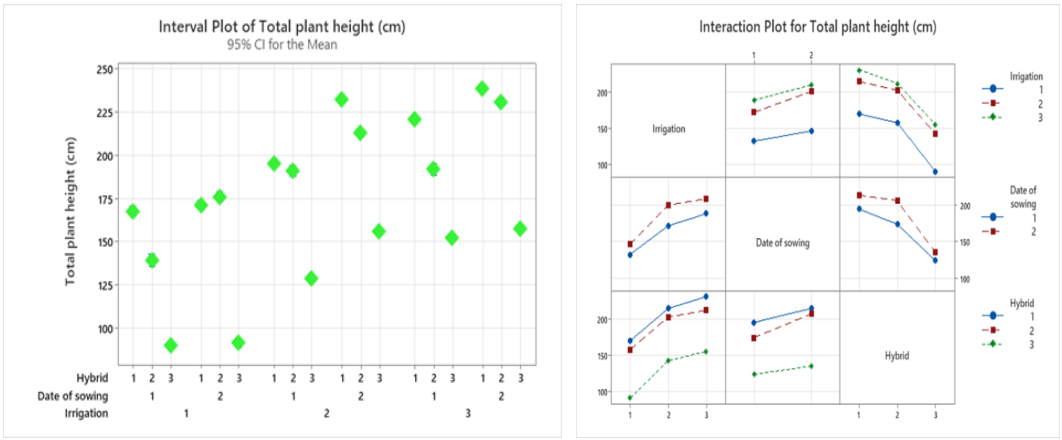
The experiment was carried out in 2022 and 2023 in the village of Bresje, the municipality of Velika Plana, the Podunavski District, Serbia. Sweet corn was grown using standard agrotechnical measures. The sowing density was about 65.000 plants per hectare (distance between rows 70 cm and between plants 22 cm). The experiment was set up in a completely randomised block design with four replications and the following factors: irrigation norm, genotype, and sowing date.

Irrigation was carried out with a drip system with strips with a capacity of 10 l•m-1•h, placed between the rows. The applications were: (1) full norm (100%) - calculated by the formula; (2) reduced norm (50%) - half of the full norm; (3) control - in the conditions of the natural wetting regime. The soil samples were analyzed in the Soil Reclamation Laboratory at the Faculty of Agriculture in Zemun. Soil moisture was monitored by tensiometers at a depth of 0.3 m at full irrigation rate. During the vegetation period, soil moisture was maintained at 60% PVK using tensiometers, which were read every 3-4 days to calculate the watering rate. The watering norm is calculated according to the formula: $Nz = 10 \times D \times (PVK\%\ vol - \theta z)$ (mm/m²), where D is the depth of the layer, PVK% vol is the hydrolimit of the field's water capacity in per cent by volume, and θz is the measured humidity. In the experiment, there were isolation belts (buffers) between treatments.

Plant material: 3 genotypes of sweet corn (1) Enterprise F1 - standard sweetness, vegetation 85 days, tall plants; (2) Union F1 - three-line hybrid, vegetation 90 days, long ear; (3) Sweet Nugget - super sweet corn hybrid, 65 days of vegetation. Sowing dates: (1) first date - end of April/beginning of May; (2) second date - mid-July, after the wheat harvest. Land preparation included ploughing and preliminary preparation. Total plant height, ear height and number of leaves were measured. The data were analyzed using ANOVA and LSD post hoc tests in IBM SPSS Statistics 26.0, with tabular and graphical displays.

RESULTS AND DISCUSSION

The total plant height of the sweet corn (Figure 1a) varied significantly across genotypes, sowing dates, and irrigation norms. The highest values were recorded for the Enterprise hybrid on the second date of sowing 239.02 cm at the full irrigation norm and 232.38 cm at the reduced norm.



(a) (b)

Figure 1a. Interval plot with 95% confidence interval for the average value for the total plant height (cm) in the two years (2022-2023) at different irrigation norms in the two dates of sowing for the tested hybrids; Figure 1b. Interaction plot for the total plant height (cm) and the influence of the observed factors in the two years (2022-2023)

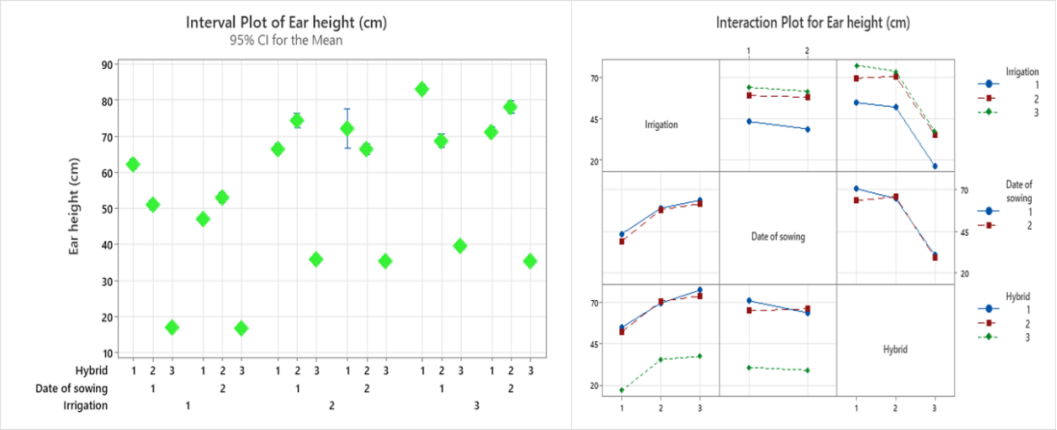
The Union hybrid reached the highest total plant height of 231.13 cm at full norm at the same sowing date, while the Sweet Nugget hybrid was significantly shorter (89.90-157.59 cm) in all treatments. Analysis of variance (Table 1) confirmed highly significant effects ($p < 0.001$) for all investigated factors (irrigation, genotype, date of sowing) and their double and triple interactions (Figure 1b).

Table 1. Analysis of variance for the factors investigated and the significance of their influence on the total plant height

Parameter	**Total plant height**			
Factor	SS	Sign.	LSD p<0.05	LSD p<0.01
Irrigation	1421956.048	**	1.366	1.795
Date of sowing	240793.400	**	1.115	1.466
Hybrid	2298680.182	**	1.366	1.795
Irrigation x Date of sowing	19470.811	**	1.931	2.539
Irrigation x Hybrid	8918.784	**	2.365	3.109
Date of sowing x Hybrid	42023.875	**	1.931	2.539
Irrigation x Date of sowing x Hybrid	47167.111	**	3.345	4.397
Total	4452925.637			

Legend: SS - sum of squares; Sign.- significance; ** p< 0.01; *p< 0.05; LSD - Least significant difference test

The obtained results are in agreement with the results of earlier research that the moisture deficit limits the growth of the above-ground part of the plant (Nemeskéri, 2019; Ugur, 2015), but at the same time they show that the reduced irrigation norm in more tolerant hybrids (Enterprise and Union) does not lead to a statistically significant reduction in total plant height, which is of extreme practical importance in conditions of limited water resources.



(a) (b)

Figure 2a. Interval plot with 95% confidence interval for the average value for the ear height (cm) for the two years at different irrigation norms in the two dates of sowing for the tested hybrids; Figure 2b. Interaction Plot for ear height (cm) and the influence of observed factors in the two years (2022-2023)

Ear height (Figure 2a) ranged from 16.57 cm (Sweet Nugget, control) to 83.04 cm (Enterprise, full norm, first date of sowing). In the Enterprise and Union hybrids, the differences between the full and reduced norms were minimal (71.25-72.13 cm for Enterprise in the second date of sowing), which indicates that the ear height did not change even with the reduced watering norm.

All investigated factors (Table 2) and their interactions (Figure 2b) were statistically significant ($p<0.01$ or $p<0.05$), consistent with the findings of Kilinça (2021) and Anil and Sezer (2003).

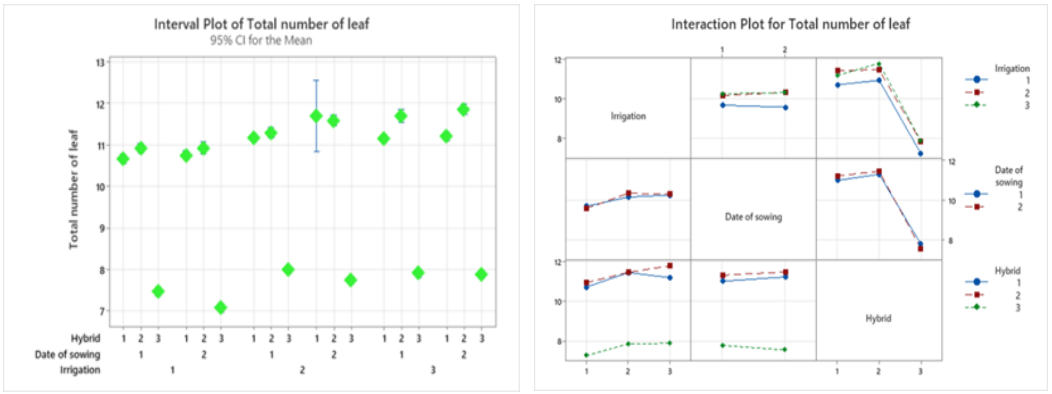
Table 2. Analysis of variance for the examined factors and the significance of their influence on ear height

Parameter	**Ear height**			
Factor	SS	Sign.	LSD $p<0.05$	LSD $p<0.01$
Irrigation	187394.045	**	1.043	1.372
Date of sowing	3513.900	**	0.852	1.120
Hybrid	632831.910	**	1.043	1.372
Irrigation x Date of sowing	1185.700	**	1.476	1.940
Irrigation x Hybrid	2571.362	**	1.807	2.376
Date of sowing x Hybrid	6467.609	**	1.476	1.940
Irrigation x Date of sowing x Hybrid	23424.247	**	2.556	3.360
Total	1075672.665			

Legend: SS - sum of squares; Sign.- significance; **$p < 0.01$; *$p< 0.05$; LSD – Least significant difference test.

The total number of leaves per plant (Figure 3a) was highest in hybrids Union (11.86 at full norm) and Enterprise (11.70 at reduced norm), while Sweet Nugget had between 7.06 and 7.98 leave.

ANOVA showed (Table 3) a significant effect of irrigation ($p<0.01$), genotype ($p<0.001$) and the interaction genotype x irrigation ($p<0.05$), but not the date of sowing or its interaction with irrigation (Figure 3b). The three-way interaction was not statistically significant. These results are in accordance with the observations of Moteva et al. (2016) and Soara (2019) that irrigation increases the number of leaves but show that in selected hybrids the reduced norm does not threaten the formation of leaf mass, thus preserving the photosynthetic potential of the plant (Zhou et al., 2019; Fujita et al., 2001).



(a) (b)

Figure 3a. Interval plot with 95% confidence interval for the average value for the total number of leaves for the two years at different irrigation norm on the two dates of sowing for the investigated hybrid; Figure 3b. Interaction Plot for the total number of leaves and the influence of the observed factors in the two years (2021-2023).

Table 3. Analysis of variance for the factors investigated and the significance of their influence on the total number of leaves

Parameter	**Total number of leaves**			
Factor	SS	Sign.	L.S.D. <0.05)	L.S.D. p<0.01
Irrigation	193.6549	**	0.131	0.173
Date of sowing	1.300	ns	0.107	0.141
Hybrid	6169.077	**	0.131	0.173
Irrigation x Date of sowing	7.778	ns	0.186	0.244
Irrigation x Hybrid	21.347	*	0.227	0.299
Date of sowing x Hybrid	20.649	**	0.186	0.244
Irrigation x Date of sowing x Hybrid	7.310	ns	0.321	0.423
Total	9874.163			

Legend: SS - sum of squares; Sign.- significance; **p< 0.01; *p< 0.05; ns - no significant difference at p >0.05 level, LSD – Least significant difference test.

CONCLUSION

The application of a reduced irrigation norm (50%) proved effective for sweet corn production, without adverse effects on total plant height, ear height, or the number of leaves in the tested genotypes across both sowing dates. This enables a 50% reduction in water consumption, contributing to sustainable resource use. In the context of climate change,

this approach represents an innovation for stable, economical production, with a recommendation for further research on kernel yield and quality.

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