DF-685
[1-7]

RESEARCH ARTICLE Agricultural Science Digest

Evaluating Water Requirements and Stress Effects on Sweet Corn (*Zea mays* saccharata) Cultivated on Loamy Sand Soil

A.A. Wahab[1], O.A. Aina[2], S.Y. Alasinrin[3], K. Agboola[2], A.A. Toyeeb[1]

10.18805/ag.DF-685

ABSTRACT

Background: This study examines the impact of water stress on sweet corn (*Zea mays* saccharata) growth and yields in loamy sand soil, Ilorin. It aims to elucidate the relationship between water stress and crop performance while identifying optimal water requirements for enhancing sweet corn development in this soil type.

Methods: The study employed a randomized complete block design (RCBD) with three replicates, featuring four crop-environmental water demand (CEWD) treatments: 100%, 75%, 50% and 25% CEWD. Water application rates (90 litres per plot every 2 days) were calculated using 12 years of meteorological data (2011-2022) for Ilorin, based on FAO crop water needs and daily evapotranspiration. Sweet corn seeds (Ex-IITA) were planted at 75 cm by 25 cm spacing. Key parameters measured included plant height, leaf count, leaf area index, biomass, days to 50% flowering, grain count and yield. Statistical analysis was conducted using Genstat 17th edition.

Result: Increased soil moisture significantly impacted plant development, with notable variations in growth rates across the four treatments. Sweet corn grain yield followed the order: 75% > 100% > 50% > 25% CEWD. No significant differences were found in flowering dates or leaf count. Mean plant height ranged from 0.627 m to 0.975 m, correlating with water application rates. The 75% CEWD treatment resulted in the highest total dry matter content and leaf area index, explaining its superior yield. The 75% CEWD level is optimal for sweet corn cultivation in Ilorin, loamy sand soil, Nigeria, promoting sustainable agriculture.

Key words: Crop-environmental water demand, Irrigation strategies, Soil moisture stress, Sustainable agriculture, Sweet corn.

INTRODUCTION

Sweet corn (*Zea mays* saccharata) is a valuable crop for its nutritional benefits and economic importance. It originated in South America and was cultivated by Native Americans long before the arrival of Europeans. It is one of the most popular vegetables in the United States and its popularity is growing rapidly all over the world (Lucier and Lin, 2001). However, vegetables can be described as foods of plant origin, usually herbaceous annuals or perennials, whose consumable parts can be eaten raw or cooked and serve as a source of vitamins, proteins and minerals (Akintoye, 2002). Unlike field corn varieties, which are harvested when the kernels are dry and ripe (dent stage), sweet corn is harvested when immature (milk stage), cooked and eaten as a vegetable rather than as a grain (Schultheis, 2010). According to James (2001) and Schultheis (2010), sweet corn develops well on almost any well-drained soil with adequate organic matter and a soil pH of 6.5-8.0. Mann (2009) reported that successful planting of sweet corn can be achieved on sandy soils, although the dominant biotic constraints are diseases, pests and weeds, while abiotic constraints include water stress (drought) and low or declining soil fertility.

In regions where water scarcity is a problem, effective water management is crucial for optimizing its growth and yield. With its unique properties, loamy sand soil requires tailored irrigation strategies to ensure adequate water availability. The availability of soil moisture typically relies on precipitation, water bodies such as streams or rivers and groundwater, which can vary in terms of distribution, intensity and quantity (Heryanto *et al.*, 2022).

Crops' response to water variability depends mainly on the growth stage of the crop at the time of weather aberration. The extent to which plants, especially corn, can withstand moisture stress depends on soil type and evapotranspiration demand (ET) (Fereres and Soriano, 2006). Evapotranspiration (ET) contributes to environmental water loss from soil and from parts of the water cycle (Jafarikouhini *et al.*, 2021). According to Hirich *et al.* (2012), short-term weather fluctuations, especially rainfall and

[1]Department of Crop Production, Kwara State University, Malete, Nigeria.
[2]Department of Soil and Environmental Management, Kogi State University, Anyigba, Nigeria.
[3]Department of Agronomy, University of Ilorin, Ilorin, Nigeria.

Corresponding Author: A.A. Wahab, Department of Crop Production, Kwara State University, Malete, Nigeria.
Email: adesina.wahab@kwasu.edu.ng

How to cite this article: Wahab A.A, Aina, O.A., Alasinrin, S.Y., Agboola, K. and Toyeeb, A.A. (2025). Evaluating Water Requirements and Stress Effects on Sweet Corn (*Zea mays* saccharata) Cultivated on Loamy Sand Soil. Agricultural Science Digest. 1-7. doi: 10.18805/ag.DF-685.

Submitted: 14-10-2024 **Accepted:** 18-03-2025 **Online:** 16-05-2025

temperature, affect the growth and yield of maize. To ensure adequate moisture in the soil for optimum plant growth and yield, an irrigation procedure based on the crop, water and soil relationship is required. It thus becomes imperative to produce food with less water than was previously available. Therefore, deficit irrigation, a strategy that attempts to use less water but conserve economic returns, could be adopted in the face of the present situation (Gull *et al.*, 2019). Thus, the need to understand the influence of water scarcity on the production of sweet corn, which is gaining rapid popularity in the WCA (Sub-Saharan Africa) and the environment, such as in Ilorin, which is prone to climate change, is of great importance. This study aims to evaluate the water requirements for sweet corn cultivated on loamy sand soil and to assess the effects of different water stress levels on its growth and yield. By understanding these dynamics, the research seeks to inform sustainable agricultural practices and improve crop productivity under varying water conditions.

MATERIALS AND METHODS

The study to evaluate water requirements and stress effects on sweet corn (*Zea mays* saccharata) cultivated on loamy sand soil was conducted at the Teaching and Research Farm of Kwara State University (KWASU), Malete (latitude 08°71′N; longitude 04°44′E) at 360 m above sea level**.** KWASU is located in Malete, Moro Local Government Area of Kwara State, Nigeria. The inhabitants of the community are engaged more in farming, hunting, transport, riding and trading. They cultivate arable crops such as cereals and legume crops. Maize is the most prominent cereal crop, while inhabitants grow quite an appreciable quantity of legumes, especially cowpea. This experiment was conducted on Plinthi Ferric Acrisol (Ditzler, 2017), which was manually cleared with a cutlass and hoe after initial soil sampling. Each side of the bed was raised to make a sunken bed. This was done to reduce run-off and soil erosion, while the inner parts were flat for free water percolation and partitioned to ensure adequate water uptake by plant roots.

Experimental design and layout

The experiment was arranged in a randomized complete block design with four replicates and four treatments, which are 100%, 75%, 50% and 25% of crop-environmental water demand. One variety of sweet corn (Ex-IITA) was used, sourced from the International Institute of Tropical Agriculture (IITA), with no pre-treatment of seeds. Each plot size was 9m^2 (9000000 mm^2), making it a sunken bed to prevent run-off and erosion and ensure that water reaches the rooting zones. Sweet corn seeds were sown with a spacing of 75 cm by 25 cm. Fertilizer application was only done to supplement the indicated imbalanced soil nutrient as reflected in pre-planting soil analysis (Table 2) with NPK 20-20-10, applied 5 days after sowing (DAS) and 21 DAS.

Water stress induction and irrigation schedule

Water application rates were based on crop-environmental water demand, determined from ten years of weather data for Ilorin (2011-2022), using daily evapotranspiration records and FAO crop water requirements. The rate of water application commenced two weeks after planting at 90 litres per plot every two days (Table 1). calculated for a 5 mm depth of water using the formula:

$$\text{Depth (mm)} = \frac{\text{Volume (cm}^3\text{)}}{\text{Area (m}^2\text{)}}$$

The irrigation water was applied using a watering can.

Soil sampling and laboratory analysis

Soil samples were taken on each plot, which were later bulked to form a composite. Core samples were equally taken to determine soil bulk density, saturated hydraulic conductivity and permeability. Routine soil analysis was carried out before the commencement of the experiment. Bulk density (core method) was estimated by dividing the oven-dry mass of the soil at 105°C by the volume of the soil as:

$$Pb = \frac{Ms}{Vb}$$

Where,
Pb = Bulk density.
Ms = Oven-dry mass of the soil.
Vb = Volume of soil in the core.
Total porosity was estimated as:

$$TP = \frac{1\text{-}Pb}{Ps} \times 100$$

Where,
Pb = Bulk density.
Ps = Particle density given as 2.65 g/cm^3.

Particle size analysis was determined using the Bouyoucous procedure. The soil textural triangle (USDA) was used to determine the soil textural class. Saturated hydraulic conductivity (KQ) was determined by the constant head method above the undisturbed core sampler (Oshunsanya, 2011). A flask of water was inverted above the core containing water to maintain a constant head of water. The quality of water (Q) drained every 5 minutes was measured until equilibrium (constant flow of water) was reached. Permeability was calculated from saturated hydraulic conductivity as follows:

$$Ks = \frac{KQ\int}{ew\ g}$$

Where:
Ks = Permeability (cm^2).
ew = Density of water (1 g/cm^3).
g = Acceleration due to gravity (980 cm/sec).
$\int$ = Viscosity at 27°C (0.00855 g/cm/sec).
KQ = Saturated hydraulic conductivity (cm/sec).

Soil chemical parameters

Soil pH: 10 ml of water was added to 10 g of air-dry soil weight (1:1) and stirred inside the plastic bottle with the aid of a glass rod. An electrode pH meter was then inserted to read the soil pH in water. Organic carbon (C) was determined using the Walkley-Black method. Total nitrogen (N) was determined using the Macro Kjedahl Method, which involves

digestion, distillation, condensation and titration. Phosphorous (P) was determined using a Mehlich III multipurpose extractant and an atomic absorption spectrometer machine was used to read the value. Potassium (K) was determined using a flame photometer as well as extractable micronutrients (mg/kg) and exchangeable bases (cmol/kg).

Data collection and analysis

The data collected includes the following: Growth parameters as like plant height (cm), number of leaves per plant and leaf area index (LAI). Yield parameters are days to 50% and 100% tasselling and silking, number of cobs per plot, grains per cobs and weight of grains (fresh and dry) (kg/ha). The leaf area index was determined using the equation below. All data were subjected to analysis of variance (ANOVA) using Genstat Discovery 17th Edition (VSNI, 2008) and means were separated using the least significant difference.

RESULTS AND DISCUSSION

The findings in Table 1 and 2 emphasize important features of soil properties, irrigation schedules and their impact on sweet corn development in this study. Table 1 shows the planned water application rates based on historical weather data and crop water needs, with 90 litres per plot applied every two days and crop-environmental water demand (CEWD) levels at 100% CEWD, while the rest were 75%, 50% and 25%-representing varying water availability scenarios. This planned irrigation scheme allows the experiment to explore the effects of water stress on sweet corn.

Table 1: Water application after sowing.

Crop-environmental water demand (%) (CEWD)	Water application /2 days (litres)
100	90.0
75	62.5
50	45.0
25	22.5

Table 2: Pre-planting chemical and physical properties of soil used for the experiment.

Parameters	Values
pH (H_2O)	6.3
Particle size distribution (g/kg)	
Sand	820
Silt	97
Clay	83
Textural class (USDA)	Loamy sand
Bulk density (kg/m^3)	1.26
Saturated hydraulic conductivity (cm/s)	4.48×10^{-3}
Permeability (cm2)	3.9×10^{-7}
Total porosity (%)	48
Organic carbon (g/kg)	14.3
Total N (g/kg)	1.64
Available P (mg/kg)	28.0
Exchangeable bases (cmol/kg)	
K	0.3
Na	0.6
Mg	2.8
Ca	30.8
Extractable micronutrients (mg/kg)	
Fe	165.2
Mn	354.2
Zn	13.5

Table 2 shows pre-planting soil properties that are important for understanding soil health and its impact on plant growth. The soil pH of 6.3 indicates a slightly acidic to neutral environment favourable to crop growth (FFDN, 2002). The soil's texture, described as loamy sand, is dominated by sand (820 g/kg), with minor levels of clay (83 g/kg) and silt (97 g/kg). According to Li *et al.* (2020), loamy sand soil promotes adequate drainage and reduces the danger of waterlogging. However, its comparatively low organic carbon content (14.3 g/kg) and total nitrogen (1.64 g/kg) indicate possibly restricted nutrient availability, necessitating nutrient supplementation for optimal sweet corn development (Ngo and Cavagnaro, 2018). Additional soil physical properties, such as a bulk density of 1.26 kg/m^3 and a saturated hydraulic conductivity of 4.48×10^{-3} cm/s, indicate moderate soil compaction and water transmission capabilities. Fereres and Soriano (2006) reported that these traits are vital for determining the soil's capacity to retain water and allow root penetration. The total porosity of 48% also suggests sufficient space for water and air movement, contributing to favourable conditions for crop development (Oshunsanya, 2010).

The nutritional assessment indicates a mixed nutrient profile, with fairly adequate levels of phosphorus (28.0 mg/kg) and rather balanced amounts of potassium, magnesium and calcium. However, according to Schultheis's (2010) results, zinc (Zn) insufficient (13.5 mg/kg) may limit sweet corn growth if not treated with fertilizer. Furthermore, while iron (165.2 mg/kg) and manganese (354.2 mg/kg) are in appropriate proportions (FFDN, 2002), the study underscores the need for monitoring micronutrient availability, particularly zinc, which is crucial for plant development. The pre-planting soil analysis offers critical baseline data for the experiment and assures that soil amendments or nutrient supplementation may be provided as needed without jeopardizing the study outcomes. Based on soil test findings, nitrogen-holding capacity and nutrient imbalances can be addressed. These approaches are consistent with sustainable agriculture management, assuring responsible resource use while increasing crop output.

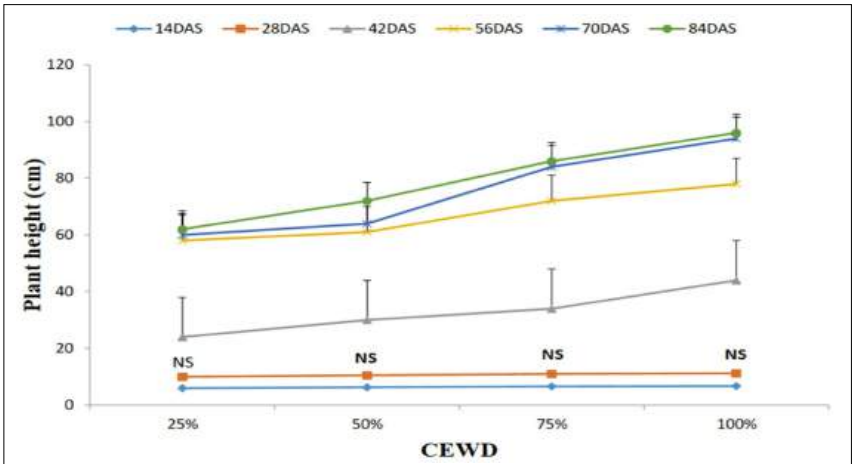
Relevant research, such as those by You *et al.* (2019), Orwin and Wardle (2005) and Ngo and Cavagnaro (2018), highlights the close relationship between soil characteristics, plant development and microbial interactions. These studies emphasize the relevance of organic matter, nitrogen and soil porosity in promoting

plant variety and nutrient cycling, as well as the requirement for intelligent soil management methods.

Fig 1-3 show the impact of different CEWD treatments on sweet corn growth parameters in this study. The results demonstrate the significant impacts of crop-environmental water demand and its influence on sweet corn growth, specifically plant height, leaf number and leaf area index (LAI), measured at different growth stages. The findings show that sweet corn's response to varying water availability is significant, influencing key agronomic traits critical to plant development and overall productivity.

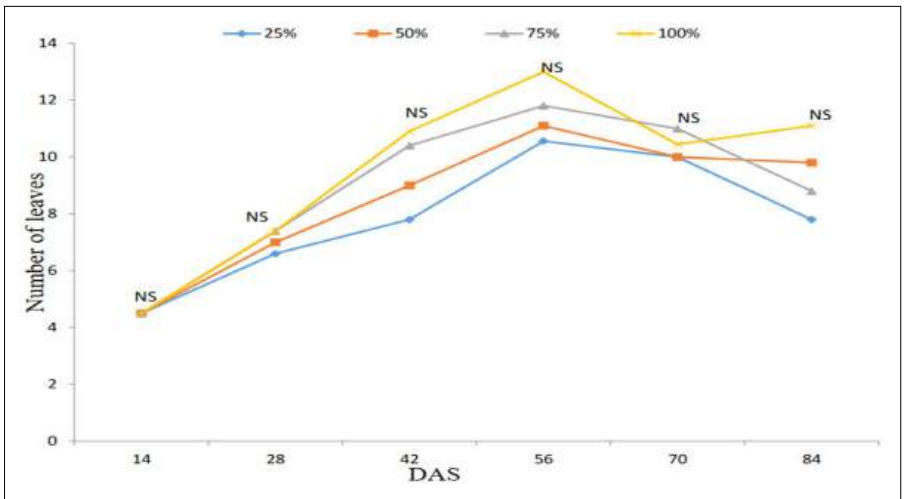
Sweet corn plant height and water availability

Fig 1 demonstrates the relationship between CEWD and sweet corn plant height at six growth stages: 14, 28, 42, 56, 70 and 84 days after sowing (DAS). The data show that higher CEWD levels correspond to greater plant height, with the tallest plants observed at 100% CEWD across all stages. Plant height ranged from 6.8 cm to 7.4 cm at 14 DAS and by 84 DAS, plant height increased from 62.7 cm to 97.5 cm, with a positive correlation between plant height and water availability. Notably, there were no significant differences in plant height between 14 and 28 DAS, but by 42 DAS, significant differences emerged between treatments, showing a hierarchy of 100% > 75% > 50% > 25% CEWD. Higher CEWD consistently increases plant height due to better soil moisture availability, a key growth factor. Zystro *et al.* (2021) and Bhukari *et al.* (2022) noted that taller sweet corn benefits from improved weed competitiveness under adequate moisture, aligning with this study's findings. Similarly, Shelton and Tracy (2015) associated plant height with weed suppression, reinforcing that sufficient water enhances sweet corn's growth and competitive traits, highlighting the critical role of water in optimizing plant development.



NS: Not significant; DAS: Days after sowing; crop-environmental water demand (CEWD.)

Fig 1: Trend of CEWD on sweet corn plant height (cm).



NS: Not significant; DAS: Days after sowing; 25%, 50%, 75% and 100% = CEWD.

Fig 2: Effect of CEWD on sweet corn number of leaves.

Number of leaves and water stress

Fig 2 shows the influence of CEWD on the number of sweet corn leaves at different stages. The findings suggest a general rise in leaf number with plant development, although there were no statistically significant differences across treatments. At 14 DAS, all plants had five leaves, but by 56 DAS, disparities had arisen, with plants under 100% CEWD having the greatest leaf count (13). Interestingly, after 70 DAS, the 75% and 100% CEWD treatments produced the same maximum number of leaves, indicating that the plant has progressed to the source-sink stage, in which the leaves' energy and nutrients are focused toward grain filling (Akinloye 2002).

The implication of this leaf numbers data touches on the genetic basis of sweet corn's growth habits, with Hu *et al.* (2021) highlighting the genetic factors role in determining plant architecture, including leaf development. The genetic influence could explain the differences in leaf count under varying CEWD conditions. Moreover, the findings suggest that water stress plays a role in regulating the leave count, as environmental conditions affect plant growth, a phenomenon also observed by Mubarok *et al.* (2022) in sweet corn's agronomic characteristics.

Table 3a: Effect of crop-environmental water demand on maize biomass at harvest.

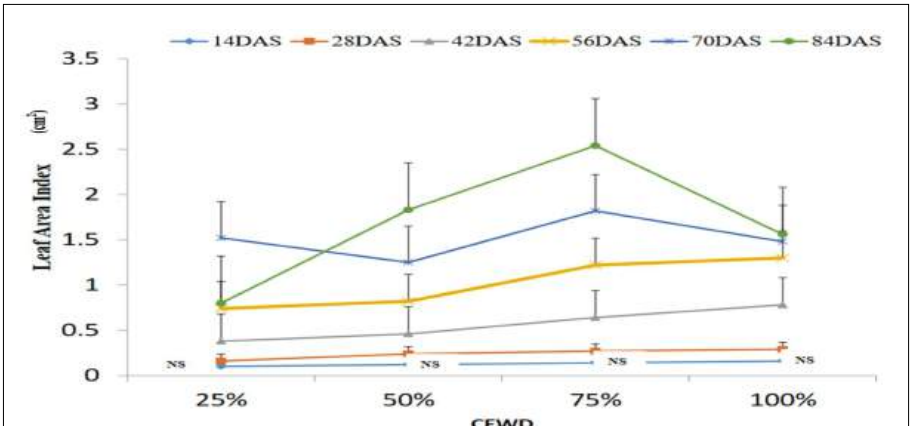
CEWD (%)	Stem dried weight	Leaves dried weight	Tassel dried weight	Total dried weight	Number of leaves
	kg/ha				
100	992	407.4	67.6	1467.3	13
75	881	373.1	54.4	1308.2	12
50	610.8	246.8	30.7	888.5	10
25	502.5	201.4	21.8	725.7	10
lsd (p<0.05)	*	*	**	**	NS
CV	16.30%	17.30%	18.40%	19.10%	7.20%

CEWD= Crop-environmental water demand; CV= Co-efficient of variation; lsd= Least significant difference (p<0.05).

Table 3b: Effect of crop-environmental Water Demand on maize yield parameters.

CEWD (%)	Days to 50%T	Days to 100%T	Days to 50%S	Days to 100%S	COB/PLT	Grains /PLT	COB fresh WGT	COB dried WGT
						kg/ha		
100	53	65	63	72	1.6	207	3093	2145.4
75	53	64	63	71	1.3	201	2760	1728.7
50	57	73	68	78	1.1	165	1876.1	1365.4
25	60	73	69	79	1.1	121	1188.5	912.8
lsd (p<0.05)	NS	*	NS	NS	NS	**	**	**
CV (%)	2.1	7.6	10.6	8.3	18.3	7.2	7.6	7.8

CEWD= Crop-environmental water demand; DAS= Days after sowing; WGT= Weight; PLT= Plant; NS= Not significance; T= Tasseling; S= Silking.



NS: Not significant; DAS: Days after sowing; CEWD: crop-environmental demand.

Fig 3: Trend of CEWD on sweet corn leaf Area Index.

Leaf area index and ground cover capability

Fig 3 presents data on the leaf area index (LAI), a critical parameter reflecting sweet corn's ability to capture sunlight and cover the ground, at different growth stages under various CEWD levels. The results indicate that the LAI fluctuated across development stages, with no significant differences at 14 and 28 DAS. However, from 42 to 56 DAS, significant differences were observed, with 75% and 100% CEWD treatments showing higher LAI values than those at 25% and 50% CEWD. By 70 and 84 DAS, the 75% CEWD treatment produced the highest LAI, even surpassing the 100% CEWD plants. This finding underscores the critical role of soil moisture in regulating LAI, a key productivity indicator. Wasan *et al.* (2023) emphasized that water availability and nutrient management significantly improve LAI, aligning with this study's observation of higher LAI under favourable water conditions. Ghanizadeh *et al.* (2014) and Kumari *et al.* (2024) highlighted LAI's importance in weed management through increased ground cover, reducing weed competition. However, in this study, LAI variations were primarily attributed to water stress rather than weed interference.

Sweet corn biomas and yield

Table 3a and 3b illustrate the impact of crop-environmental water demand (CEWD) on maize biomass and yield parameters. As CEWD decreases from 100% to 25%, significant declines are observed in biomass components (stem, leaves, tassel dried weights and total dried weight) and yield parameters (grain yield, cob weight and harvest index). Variability is higher in tassel dried weight and grain yield, reflecting the sensitivity of maize growth to water stress. Reduced water availability limits nutrient uptake and plant productivity, aligning with findings by Salmerón *et al.* (2011), Ruf and Emmerling (2022) and Li *et al.* (2020). Efficient irrigation and nutrient management are crucial for sustaining maize productivity under water stress.

CONCLUSION

The study reveals that higher crop-environmental water demand (CEWD) boosts sweet corn growth, enhancing plant height, leaf count and leaf area index (LAI). Plots treated with 75% CEWD achieved the highest dry matter content and LAI, driving superior grain yield. Sweet corn growth and yield in loamy sandy soil were optimal at 75% CEWD, sufficient for cultivation in Ilorin. Effective water management is essential for maximizing yield, highlighting the need for a holistic approach integrating soil moisture, nutrients and plant architecture for sustainable agriculture.

ACKNOWLEDGEMENT

The present study was supported by personal funding. I want to express my candid gratitude to Kwara State University, Malete, Nigeria (KWASU), for providing the study sites and supporting staff (Mr Benson Adegbosin, Mr Usman Mohammed and Mr Tayo Jimoh) who are always on the ground to support the field research.

Disclaimers

The views and conclusions expressed in this article are solely those of the authors and do not necessarily represent the views of their affiliated institutions. The authors are responsible for the accuracy and completeness of the information provided but do not accept any liability for any direct or indirect losses resulting from the use of this content.

Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this article. No funding or sponsorship influenced the study's design, data collection, analysis, decision to publish, or manuscript preparation.

REFERENCES

Akintoye H.A. (2002). Evaluation of growth and yield performance of tomato lines grown at two planting dates in South Western Nigeria. Proceedings of the Annual conference of HOTRSON held under the theme: "Horticulture for Sustainable Environment and Economic Empowerment. NIHORT, Idi-Isin, Ibadan, 14th -17* May. pp. 150-153.

Bukhari, B., Zakaria, S., Sufardi, S. and Syafruddin, S. (2022). Effect of organic amendments on the water stress resistance of corn varieties during vegetative stage in ultisols. Indian Journal of Agricultural Research. 56(3): 276-282. doi: 10.18805/IJARe.AF-711.

Ditzler, C. A. (2017). Soil properties and classification (soil taxonomy). The Soils of the USA. 29-41.

Federal Fertilizer Department of Nigeria (FFDN). (2002). Results and Interpretation of Soil Analysis. Table 2:8.

Fereres E. and Soriano M.A. (2006). Deficit Irrigation for Reducing Agricultural Water Use.

Ghanizadeh, H., Lorzadeh, S. and Aryannia, N. (2014). Effect of weed interference on *Zea mays*: Growth analysis. Weed Biology and Management. 14(2): 133-137. https://doi.org/10.1111/wbm.12041.

Gull, A., Lone, A.A., Sofi, P.A., Bhat, M.A., Maqbool, S., Ahmad, M. and Nazir, A. (2019). Root-shoot variability in sweet corn inbreds under water stress conditions. SKUAST Journal of Research. 21(2): 197-203.

Heryanto, F., Wirnas, D. and Ritonga, A. (2022). Diversity of twenty-three sweet corn [*Zea mays* (L.) saccharata] varieties in Indonesia. Biodiversitas Journal of Biological Diversity. 23(11): https://doi.org/10.13057/biodiv/d231164.

Hirich A., Rami A., Laajaj K., Choukr-Allah R., El youssfi L, El Oman H. (2012). Sweet corn water productivity under several deficit irrigation regimes applied during the vegetative growth stage using treated wastewater as a water irrigation source. World Academy of Science, Engineering and Technology. 61 (2012): 23-69.

Hu, Y., Colantonio, V., Müller, B., Leach, K., Nanni, A., Finegan, C. and Resende, M. (2021). Genome assembly and population genomic analysis provide insights into the evolution of modern sweet corn. Nature Communications. 12(1): https://doi.org/10.1038/s41467-021-21380-4.

Jafarikouhini, N., Sinclair, T. and Resende, M. (2021). Limited transpiration rate and plant conductance in a diverse sweet corn population. Crop Science. 62(1): 374-381. https://doi.org/10.1002/csc2.20664.

James, D.U. (2001). Sweet corn production. John Jett, Extension specialist service, Horticulture. Ohio State University: 11-23 Journal of Experimental Biology. 58(2): 147-159. www.wvu.eduagrexten/hortcult/homegarden/com. pdf.

Kumari, S., Tzudir, L., Gohain, T., Singh, A. P., Nongmaithem, D., Yadav, R. and Dutta, M. (2024). Response of sweet corn (*Zea mays saccharata* L.) to varying tillage methods and seaweed bio-stimulant application. Indian Journal of Agricultural Research. 1: 6. doi: 10.18805/IJARe.A-6214.

Li, Y., Cui, S., Zhang, Z., Zhuang, K., Wang, Z. and Zhang, Q. (2020). Determining effects of water and nitrogen input on maize (*Zea mays*) yield, water- and nitrogen-use efficiency: A global synthesis. Scientific Reports. 10(1): https://doi.org/10.1038/s41598-020-66613-6.

Lucier, G. and Lin BiingHwan, L.B. (2001). How sweet it is: Fresh sweet corn. Publisher: US Department of Agriculture, Economic Research Service (ERS-NASS). Agricultural Outlook. 2001, No .283: 11-14.

Mann, C.K. (2009). 1491: New Revelations of the Arner^a^before Columbus. ^ ^ Vintage ISBN 1-4000-3205-9: pp 221.

Mubarok, S., Wicaksono, F. Y., Nuraini, A., Rahmat, B.P.N. and Budiarto, R. (2022). Agronomical characteristics of sweet corn under different plant growth regulators during the dry season. Biodiversitas Journal of Biological Diversity. 23(6). doi: 10.13057/biodiv/d230636.

Ngo, H.T.T. and Cavagnaro, T.R. (2018). Interactive effects of compost and pre-planting soil moisture on plant biomass, nutrition and formation of mycorrhizas: A context- dependent response. Scientific Reports. 8(1): 1509. doi:10.1038s41598-017-18780-2.

Orwin, K.H. and Wardle, D.A. (2005). Plant species composition effects on belowground properties and the resistance and resilience of the soil microflora to a drying disturbance. Plant and Soil. 278: 205-221. DOI 10.1007/s11104-005-8424-1.

Oshunsanya S.O. (2011). Soil physics. Soil physics textbook. Published by Dabank, P.O. Box 9222, U.I. Post Office; Ibadan, Nigeria. Chapter. 5: 79-96.

Ruf, T. and Emmerling, C. (2022). Biomass partitioning and nutrient fluxes in silphium perfoliatum and silage maize cropping systems. Nutrient Cycling in Agroecosystems. 124(3): 389-405. https://doi.org/10.1007/s10705-022-10242-0.

Salmerón, M., Isla, R. and Cavero, J. (2011). Effect of winter cover crop species and planting methods on maize yield and N availability under irrigated Mediterranean conditions. Field Crops Research. 123(2): 89-99.

Schultheis J.R. (2010). Sweet corn production II. North Carolina Cooperative Extension Service; State, North Carolina State University, U.S.A., Department. Revised. 12(94): 201.

Shelton, A.C. and Tracy, W.F. (2015). Recurrent selection and participatory plant breeding for improvement of two organic open-pollinated sweet corn (*Zea mays* L.) populations. Sustainability. 7(5): 5139-5152: doi:10.3390/su7055139.

VSN International (VSNI). 2008. The Genstat Discovery Edition 3. Genstat Procedure Library Release PL 15.2. www.vsni.co.uk.

Wasan, J.P.M., Pyle, L.A. and Bennett, J.A. (2023). Disturbance and nutrient availability drive absinthe *(Artemisia absinthium)* invasion in a native rough fescue grassland. Ecoscience. 30(1): 27-38. https://doi.org/10.1080/1956860.2023.12165283.

You, J., Sun, L., Liu, X., Hu, X. and Xu, Q. (2019). Effects of sewage sludge biochar on soil characteristics and crop yield in loamy sand soil. Pol. J. Environ. Stud. 28(4). 2973-2980. doi: 10.15244/pjoes/93294.

Zystro, J., Peters, T.E., Miller, K.M. and Tracy, W.F. (2021). Inbred and hybrid sweet corn genotype performance in diverse organic environments. Crop Science. 61(4): 2280-2293. doi: 10.1002/csc2.20457.