THE COMBINED EFFECT OF DEFICIT IRRIGATION AND THE TECHNOLOGY OF KYMINASI PLANT BOOSTER ON MAIZE

TRIAL REPORT & FINAL ANALYSIS

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ENA Meknès – École Nationale d'Agriculture de Meknès – National School of Agriculture, Morocco . June 2024

Outline

01. Materials and methods
02. Results and Discussion
03. Conclusion
04. Recommendations
05. Glossary

Materiels and methods

The experimental plot

	Meknès, Morocco
Plot area	0.33 Ha
Spacement	0.7*0,12 m
Seeding rate	100000 plants/Ha
Seedling Date	March 22, 2024
Harvesting Date	July 22, 2024

Coordinates: 33.843125, -5.473424

The experimental plot

Treatment Number	Description
T1	100% ETC* application without Kyminasi
T2	100% ETC application + Kyminasi
T3	80% ETC application without Kyminasi
T4	80% ETC application + Kyminasi
T5	60% ETC application without Kyminasi
T6	60% ETC application + Kyminasi

** ETc: Crop Evapotranspiration*

Granulometric composition and chemical parameters of the soil

Parameters	Value
Sand (%)	16.1
Silt (%)	36.3
Clay (%)	47.6
pH	7.74
Total limestone (%)	12.8
Active limestone (%)	6.3

By Ferticonseil in ENA, Meknès, Morocco

Irrigation management

Extract of the irrigation program for the 100% ETc control treatment

DATES	Mois	Tmin	Tmax	Tmean	GDUs	%P	ET0 (mm)	Précipitations (mm)	Réserve (mm)	D.A.S	Stage	Kc	ETC (mm)	NB apports réel
29-avr.-24	4	6,89	15,26	13,075	369	0,29	1,70	6,4	13,86	37	Dev.	0,80	1,36	0
30-avr.-24	4	5,5	17,28	13,39	374	0,29	2,10	0,0	17,62	38	Dev.	0,80	1,68	0
1-mai-24	5	5,78	19,71	14,745	381	0,31	2,70	0,0	15,94	39	Dev.	0,80	2,16	0
2-mai-24	5	8,19	18,82	15,505	389	0,31	2,40	0,0	13,78	40	Dev.	0,80	1,92	0
3-mai-24	5	4,74	24,81	16,775	398	0,31	3,90	0,0	11,86	41	Dev.	0,80	3,12	0
4-mai-24	5	7,36	26,52	18,94	409	0,31	4,50	0,0	8,74	42	Dev.	0,80	3,60	0
5-mai-24	5	7,88	26,19	19,035	420	0,31	4,10	0,0	5,14	43	Dev.	0,80	3,28	0
6-mai-24	5	12,24	23,77	20,005	432	0,31	3,10	0,0	1,86	44	Dev.	0,80	2,48	0
7-mai-24	5	8,67	29,02	20,845	445	0,31	4,60	0,0	0,00	45	Dev.	0,80	3,68	2
8-mai-24	5	13,71	32,68	25,195	461	0,31	4,90	0,0	0,00	46	Dev.	0,80	3,92	2
9-mai-24	5	12,29	31,92	24,105	476	0,31	4,40	0,0	0,00	47	Dev.	1,00	4,40	3
10-mai-24	5	15,2	32,92	26,06	493	0,31	4,30	0,0	0,00	48	Dev.	1,00	4,30	2
11-mai-24	5	15,89	30,35	25,12	510	0,31	3,90	0,0	0,00	49	Dev.	1,00	3,90	2
12-mai-24	5	15,1	26,29	22,695	524	0,31	3,20	0,0	0,00	50	Dev.	1,00	3,20	2
13-mai-24	5	13,62	25,92	21,77	538	0,31	3,40	0,0	0,00	51	Dev.	1,00	3,40	2

IRRIGATION	
f	0,05
Psh (%)	80,0%
RFU (mm)	52
DNM (mm)	2,07

Maize	
Stage	Kc
Dev.	0,80
Init.	0,30
Late	0,60
Mid.	1,20
Fao 56	

Water requirements

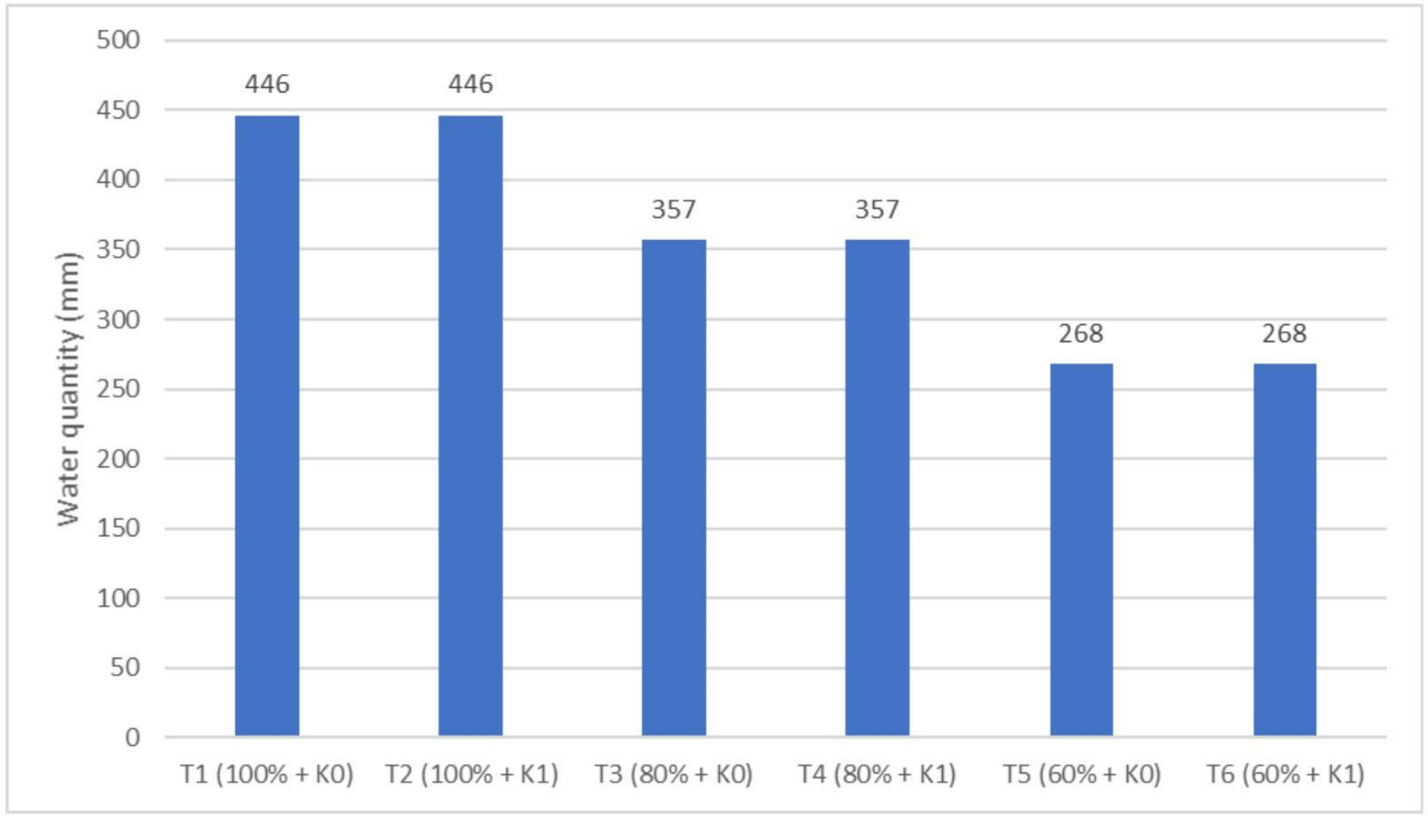
$$ETc = Kc * ETo$$

Readily Available Water (RAW)

$$RAW = f * (HFC - HPWP) * Rd * PHs$$

Irrigation management

The water quantity (delivered to the plants) per hectare in each treatment



Parameters monotoring

Growth and development parameters

Collar diameter

Height

Parameters monotoring

Eco-physiological parameters

Chlorophyll

Stomatal conductance

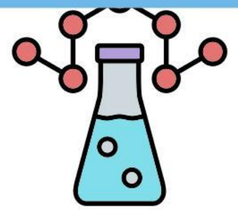
Parameters monotoring

Destructive measurement

Leaf Water potential

Yield

Parameters monotoring



Biochemical analysis

Proline content

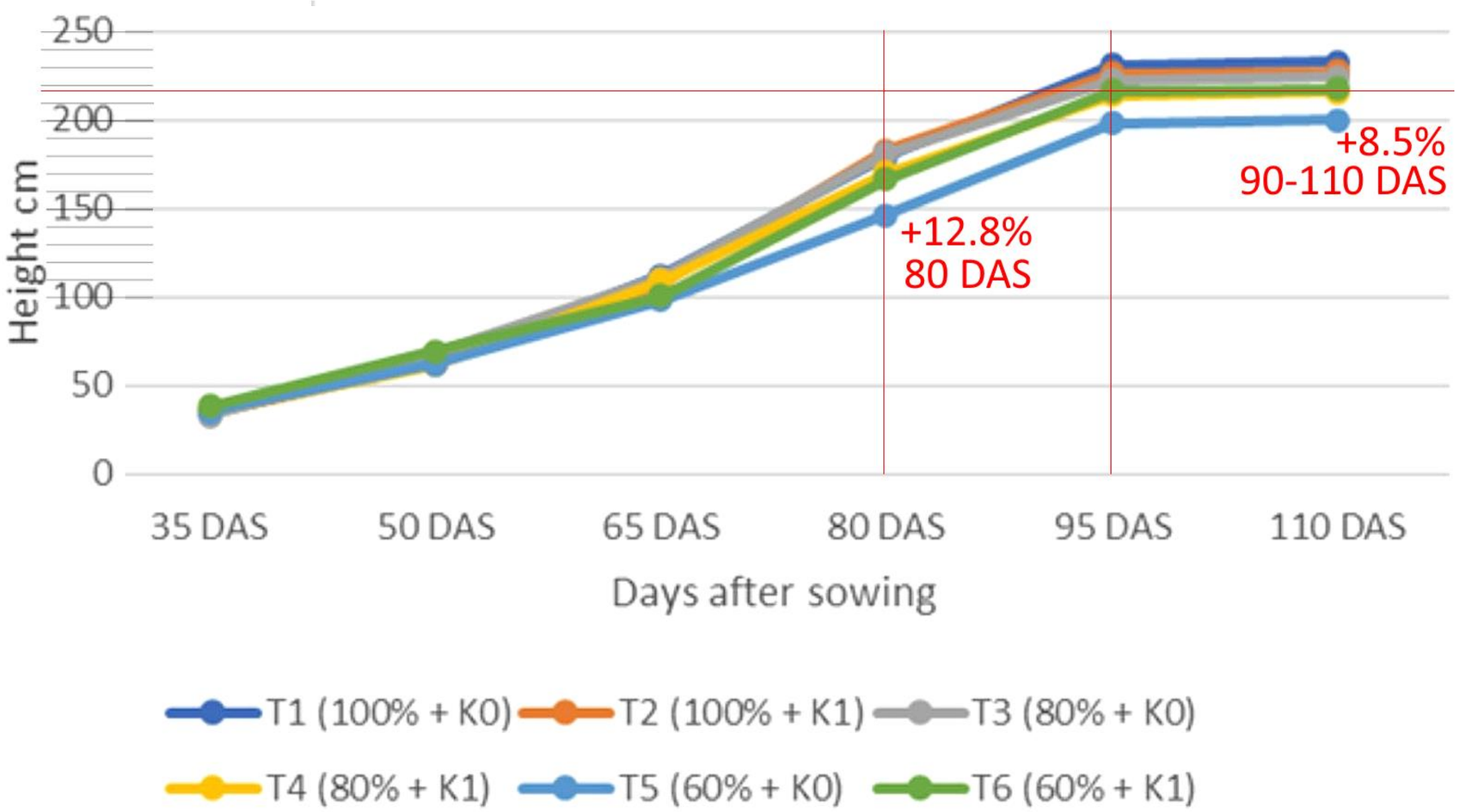
Protein

Data analysis and treatment

The data was analysed and treated with two important softwares which are

Results and discussion

Height evolution

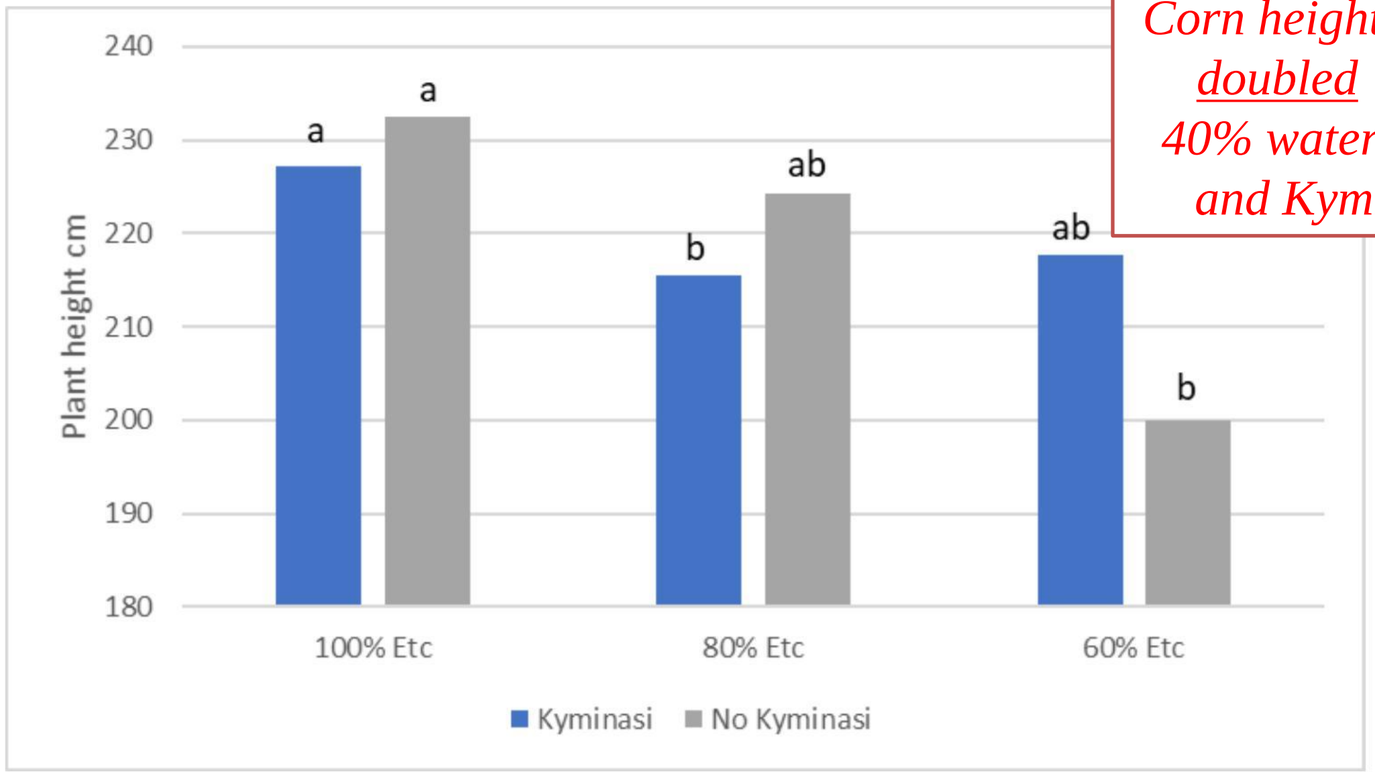


AT GROWTH STAGES: With 40% water stress and Kyminasi, the maize plants were 12.8% taller at 80 DAS and 8.5% taller at 90-110 DAS

K1: with Kyminasi
K0: without Kyminasi

Height at harvesting time

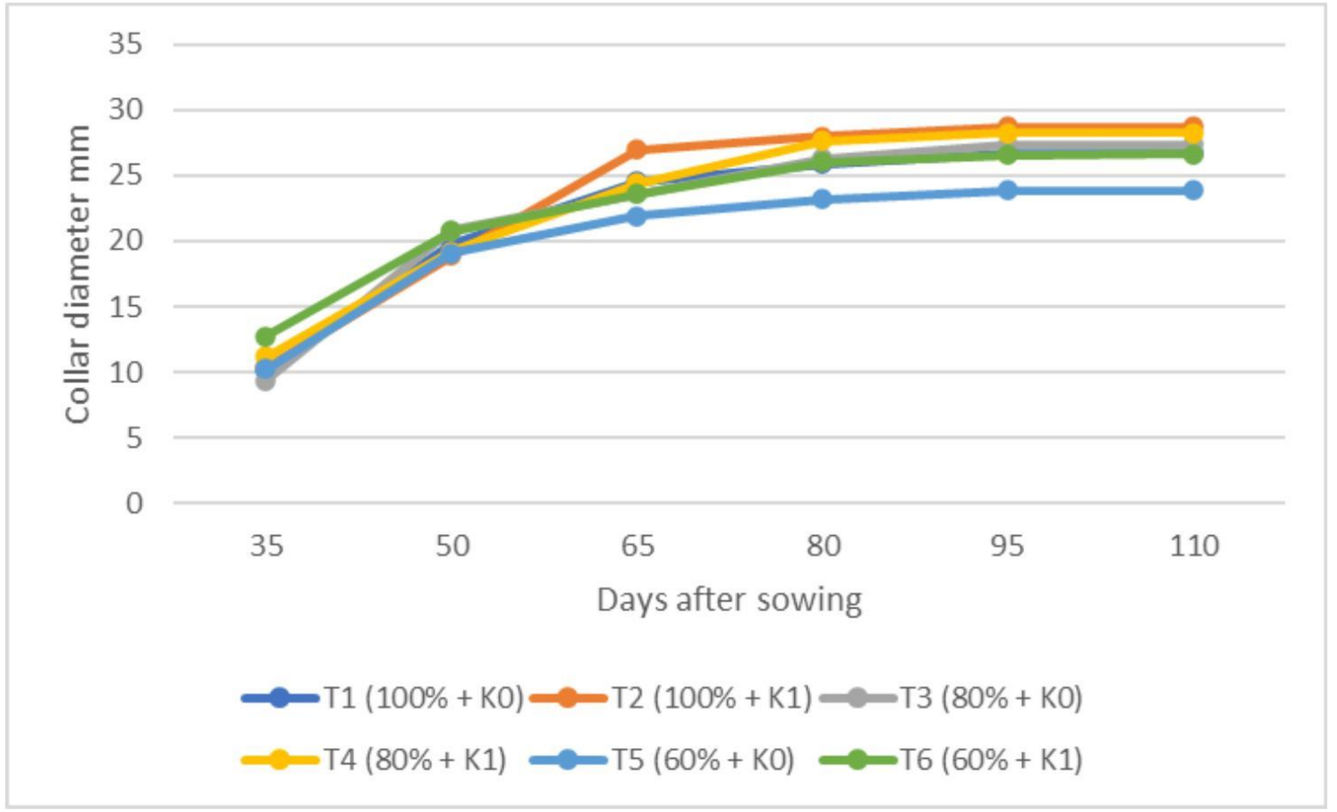
AT HARVEST:
Corn height nearly doubled with 40% water stress and Kyminasi



DI	*
K	n.s
K*DI	n.s

K1: with Kyminasi
K0: without Kyminasi

Collar diameter evolution

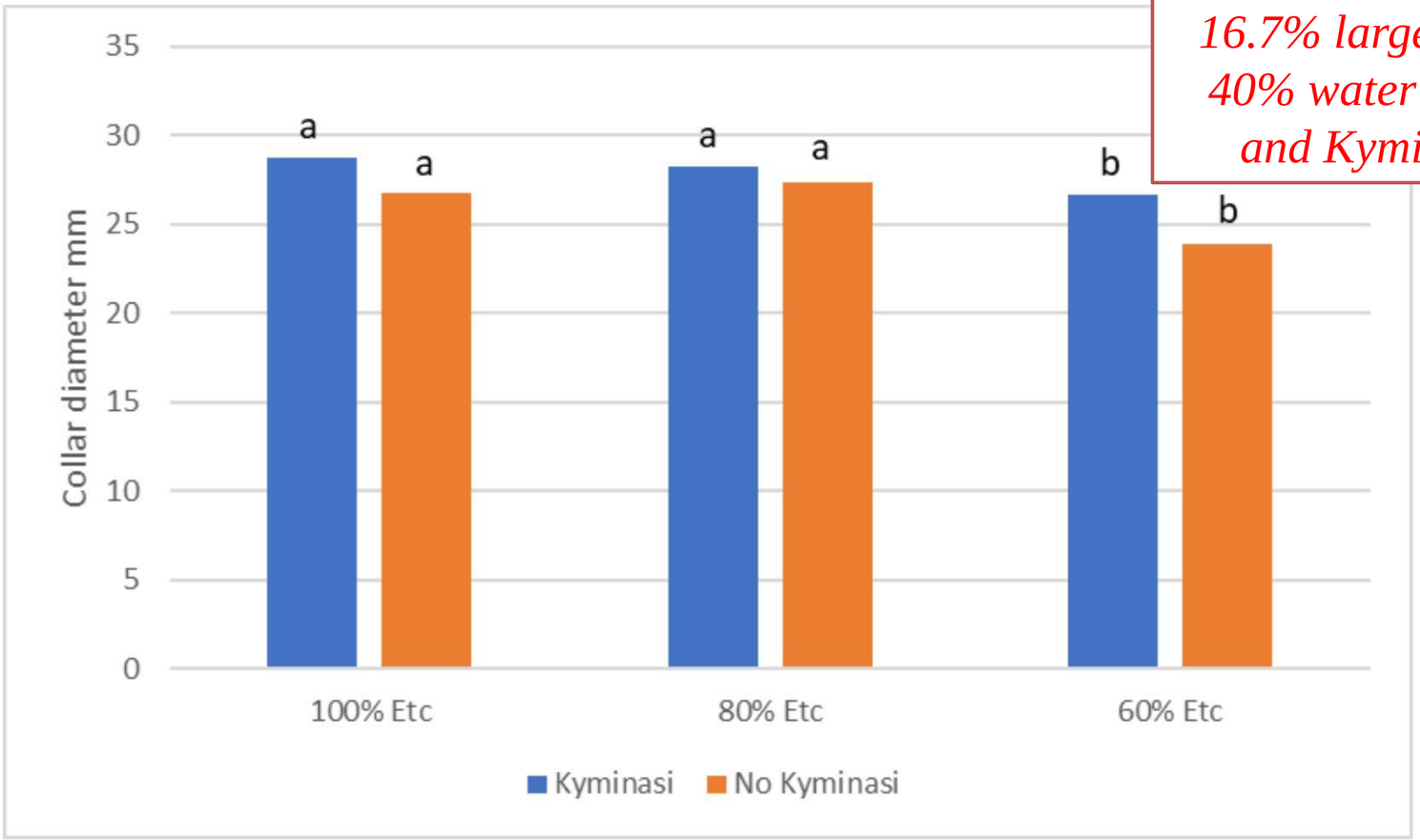


AT GROWTH STAGES:
With 40% water stress and Kyminasi, collar diameter was 7.4% larger at 80 DAS and 8% larger at 95 DAS

K1: with Kyminasi
K0: without Kyminasi

Collar diameter at harvesting time

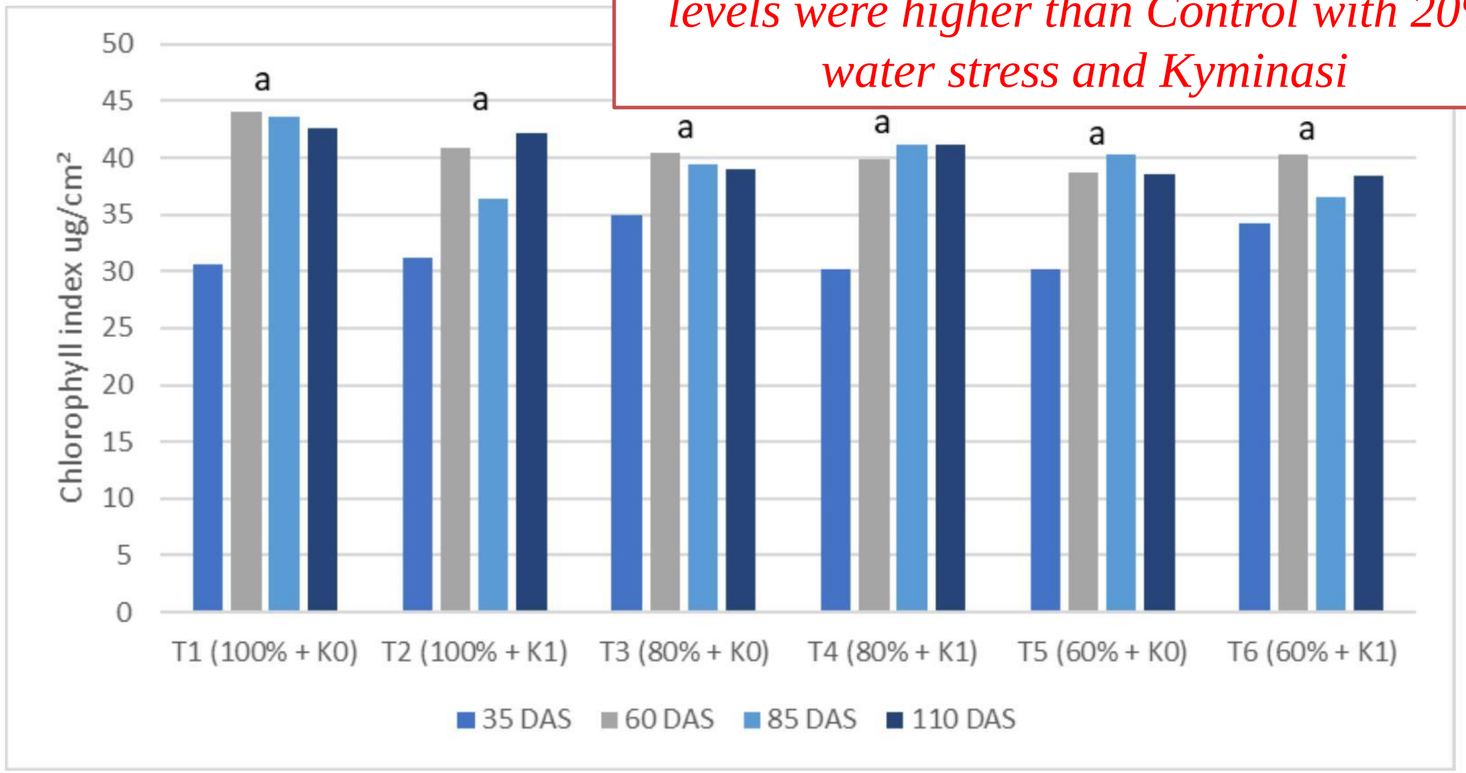
AT HARVEST: Collar diameter was 16.7% larger with 40% water stress and Kyminasi



DI	*
K	*
K*DI	n.s

Chlorophyll index evolution

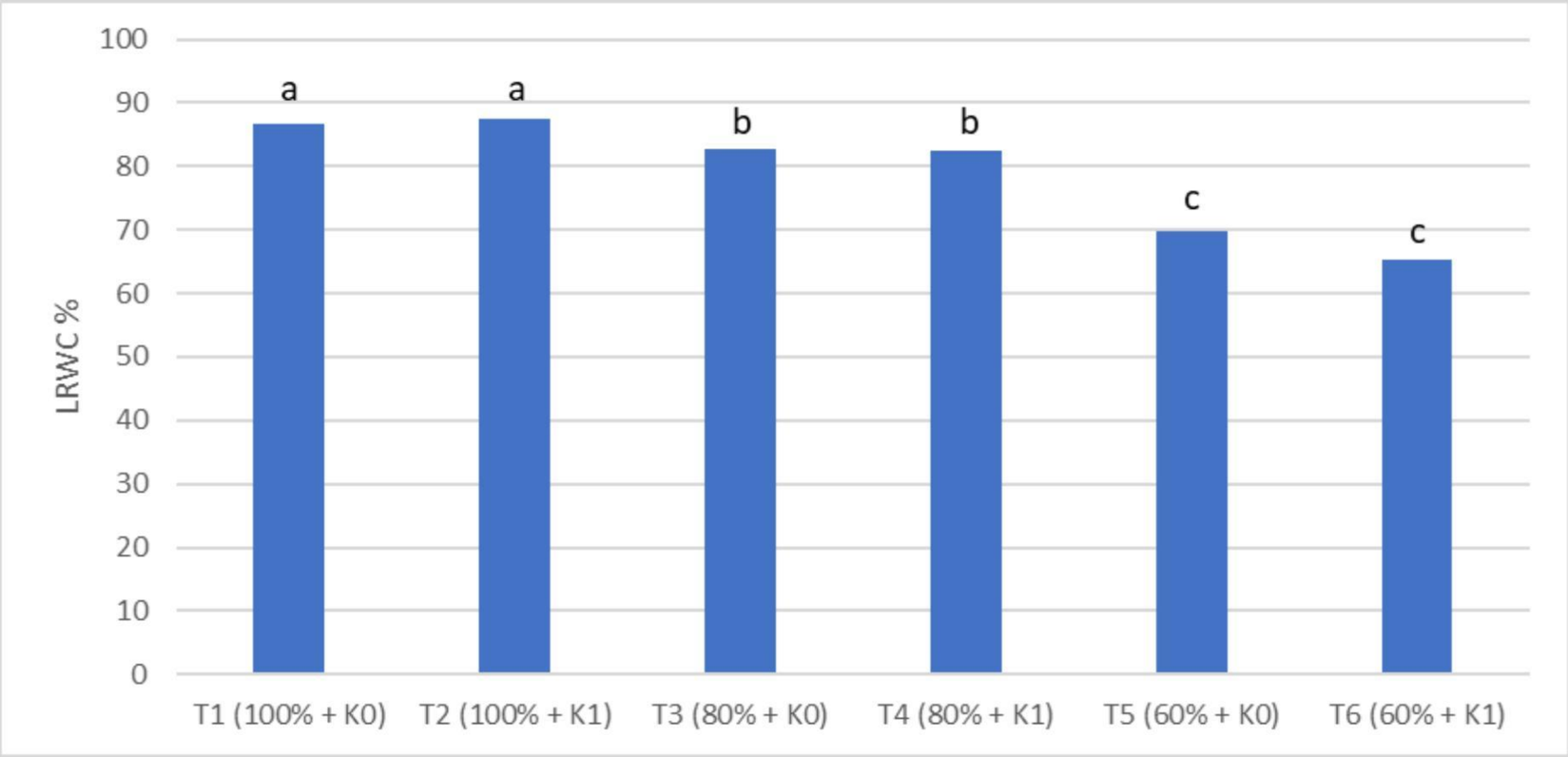
AT GROWTH STAGES:
Between 85 DAS and 110 DAS, chlorophyll levels were higher than Control with 20% water stress and Kyminasi



N.S.E	DI
N.S.E	K
N.S.E	K*DI

K1: with Kyminasi
K0: without Kyminasi

Leaf relative water content evolution

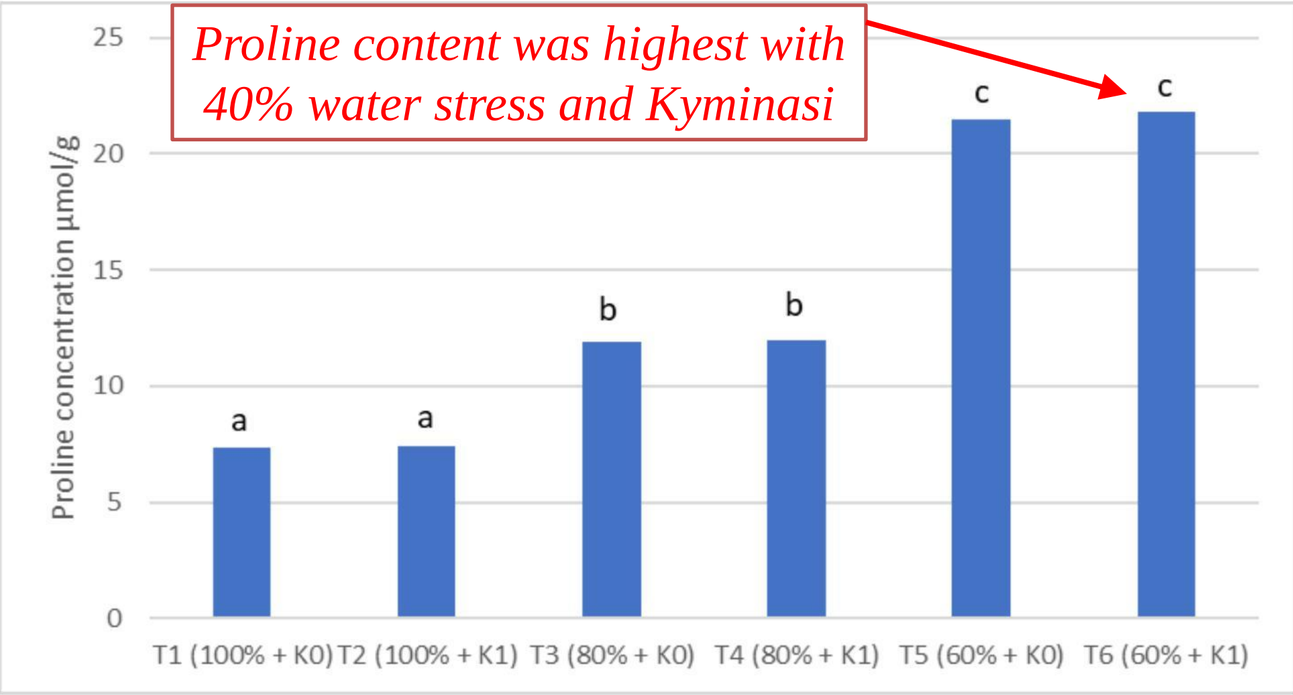


DI	*
K	n.s
K*DI	n.s

K1: with Kyminasi
K0: without Kyminasi

Proline content

Proline: amino acid that helps maize tolerate and recover from stresses:
1) abiotic stresses, e.g., drought, low temperature.
2) Water stress
3) Salinity stress.



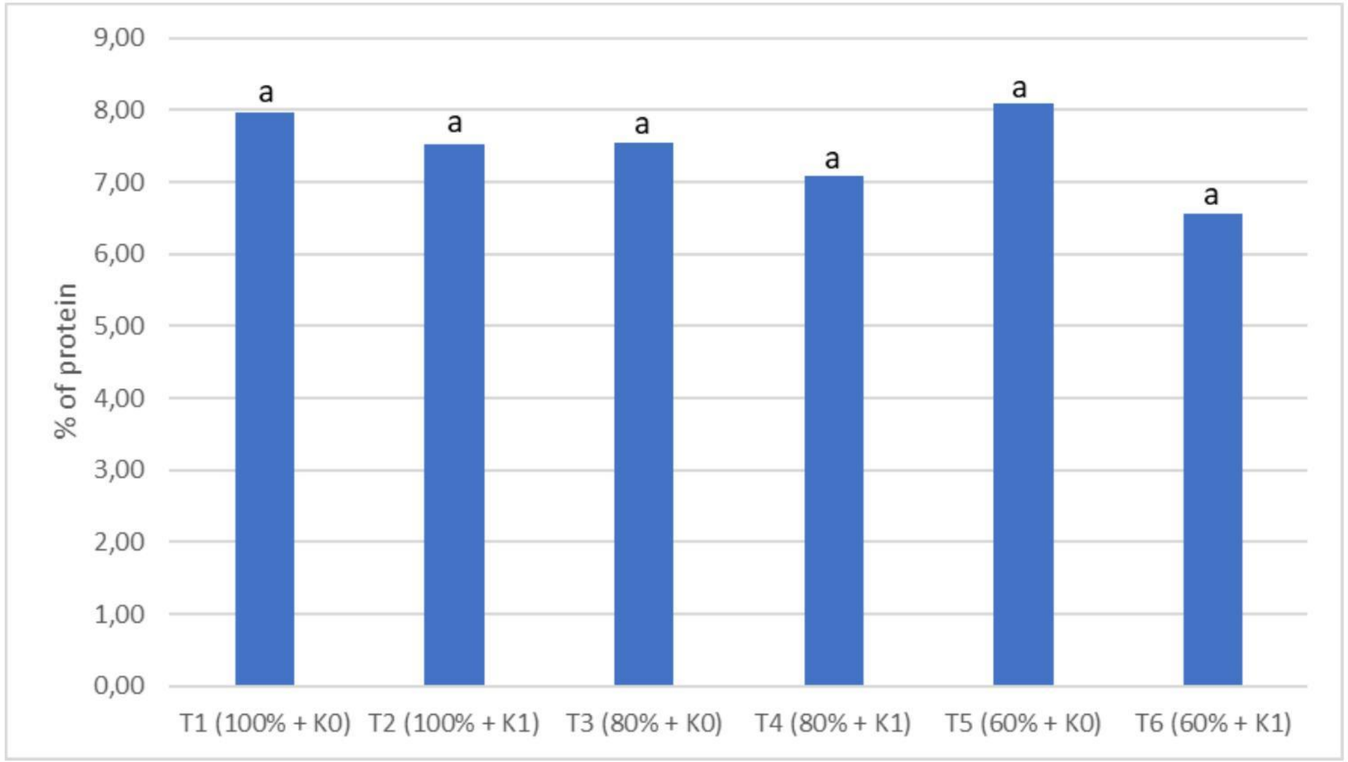
K1: with Kyminasi
K0: without Kyminasi

Moctar, 2023. Assessment of Combined Effect of Hydrogels and Continuous Deficit Irrigation in Maize (Zea mays L.): plant response and eco-toxicological characterization.

Ali, R., Khan, M., & Ahmed, Z. (2017). Proline accumulation as a response to drought stress in maize. Journal of Plant Physiology, 56(3), 218-225.

DI	*****
K	**n.s**
K*DI	**n.s**

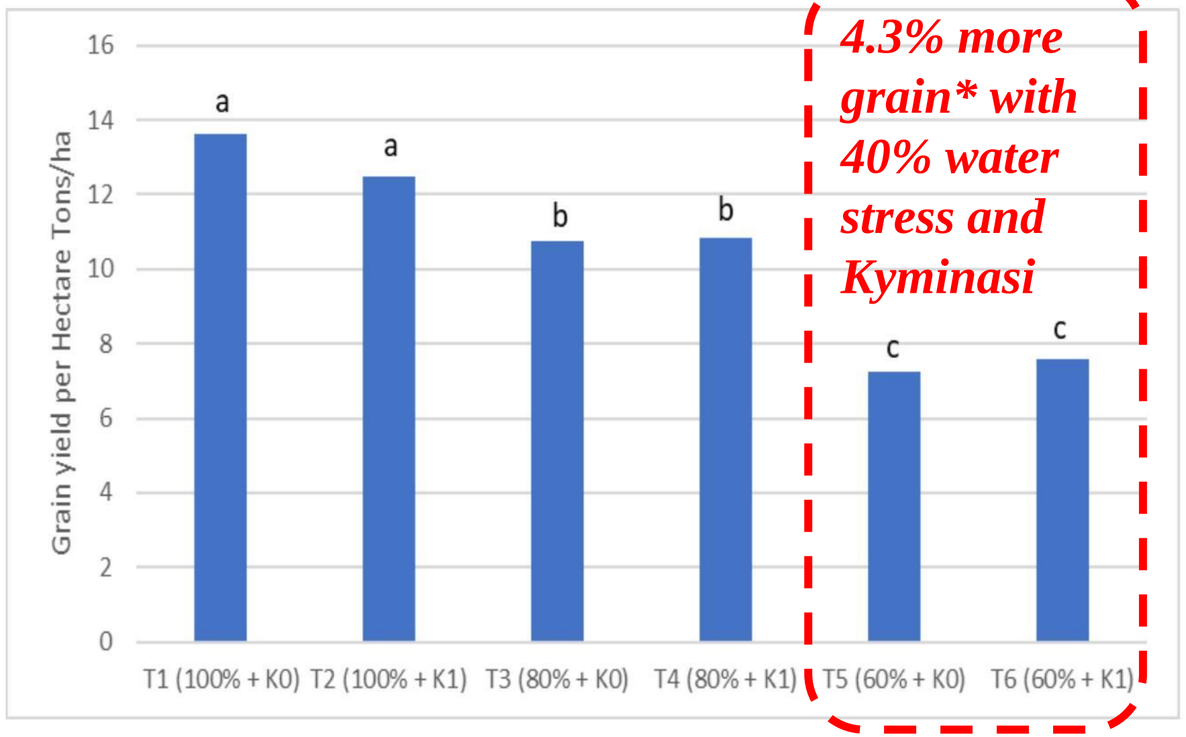
% of protein



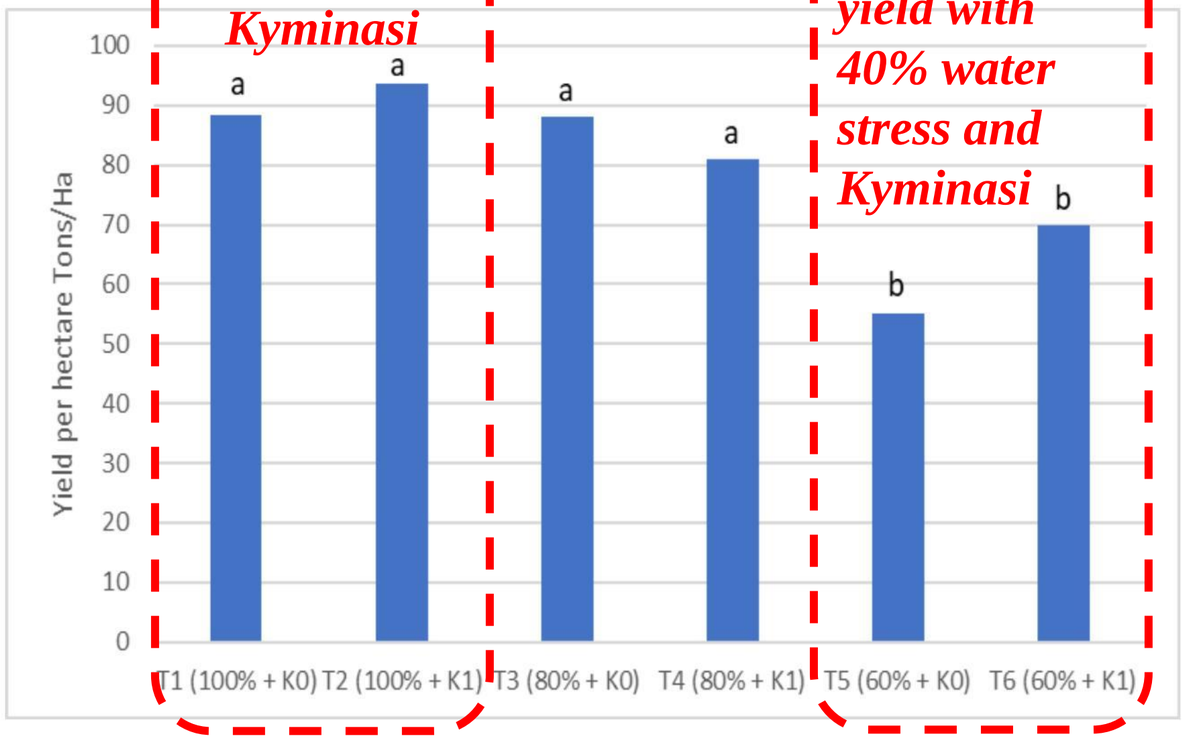
DI	n.s
K	*
K*DI	n.s

K1: with Kyminasi
K0: without Kyminasi

Grain yield and biomass yield per hectare



4.3% more grain with 40% water stress and Kyminasi*



6% higher yield with Kyminasi

27.1% higher yield with 40% water stress and Kyminasi

** Also 4.4% HIGHER GRAIN DENSITY with 40% water stress and Kyminasi (slide 24)*

DI	*
K	n.s
K*DI	n.s

Agronomic Water Use Efficiency

Treatment	Grain yield (Tons/hectare)	Biomass yield (Tons/hectare)	Water applied (m3/ha)	WUE* Grain (kg • m^{-3})	WUE Biomass (kg • m^{-3})
T1 (100% + K0)	13.61	88.25	4463.60	3.05ab	19.77b
T2 (100% + K1)	12.50	93.53	4463.60	2.80ab	20.95b +1%
T3 (80% + K0)	10.74	88.01	3570.88	3.01a	24.65a
T4 (80% + K1)	10.84	80.89	3570.88	3.04a	22.65a
T5 (60% + K0)	7.27	54.97	2678.16	2.71b	20.53a
T6 (60% + K1)	7.58	69.87	2678.16	2.83b	26.09a +20%

DI	*
K	**n.s**
K*DI	*

** WUE: Water Use Efficiency*

Economic Water Use Efficiency of Biomass Production

Treatment	Estimated biomass yield per hectare	Selling price (MAD*)	Applied irrigation water (m3/ha)	Cost of applied irrigation water (MAD)	Amortized cost of Kyminasi (MAD.ha-1 .year-1)	Total expenses (MAD)	Profit by biomass (MAD)	EWUE**b (MAD.m-3)
T1 (100% + K0)	88.25	114725.325	4463.6	5356.32	0.00	5356.32	109369.01	24.50b
T2 (100% + K1)	93.53 +6%	121587.375	4463.6	5356.32	5750.00	11106.32	110481.06	24.75b +6%
T3 (80% + K0)	88.01	114418.2	3570.88	4285.056	0.00	4285.06	110133.14	30.84a
T4 (80% + K1)	80.89	105162.2	3570.88	4285.056	5750.00	10035.06	95127.14	26.64a
T5 (60% + K0)	54.97	71460.025	2678.16	3213.792	0.00	3213.79	68246.23	25.48a
T6 (60% + K1)	69,87 +27.1%	90834,25	2678.16	3213.792	5750.00	8963.79	81870.46	30.57a +27.1%

DI	*
K	n.s
K*DI	*

** MAD: Moroccan Dirham*

*** EWUE: Economical Water Use Efficiency*

Conclusion

01 Significant effect of deficit irrigation on the most parameters.

02 Significant effect of Kyminasi crop booster technology on parameters when exposed to higher stress

03 Treatments irrigated at 80% ETc generally performed comparably to those at 100% ETc across most parameters, including plant height, stomatal conductance, and yield parameters.

04 Treatments irrigated at 60% ETc significantly impacted the most parameters

Recommendations

Maintaining irrigation levels at 80% ETc was found to provide yields that were close to those of 100% ETc,

Introduction → Material and methods → Results → Conclusion and recommendations

Avoid 60% irrigation on maize

- Parameters
- Soil health and fertility

Combine traditional water management practices with modern technics

- Cover cropping
- Mulshing

Conduct additional studies in Kyminasi, perhaps with different crop types or under varying environmental conditions, and under higher strss, to fully understand its benefits and limitations.

Harvest Harmonics' Analysis

Professor Aziz Abouabdillah and graduate student Amine Hifni of ENA university in Meknes, Morocco conducted an interesting comparative trial focusing on the effect of Kyminasi Plants Crop Booster (KPCB) on maize growth and yield with various levels of water stress: 0%, 20%, and 40% less watering; in the study: ETc 100%, ETc 80%, and ETc 60%, respectively (ETc: Crop Evapotranspiration).

Our conclusions:

- ✓ During the growth stages, with KPCB and 40% water stress, the maize plants were **12.8% taller** at 80 DAS and **8.5% taller** at 90-110 DAS.
  In parallel, collar diameter was 7.4% larger at 80 DAS and 8% larger at 95 DAS.
- ✓ At harvest, **collar diameter** was 17.6% larger with KPCB and 40% water stress, which was the largest KPCB boost compared to 20% and 0% water stress treatments.
- ✓ Between 85 DAS and 110 DAS, chlorophyll levels were higher than Control with KPCB and 20% water stress.

Harvest Harmonics' Analysis (continued)

- ✓ Under 40% water stress, **yield gain** was 27.1% with KPCB vs. Control, compared to 6% gain with KPCB alone (no water stress). Additionally, between all the six treatments, **proline** content was the highest with KPCB and 40% water stress, indicating a ***boost in maize drought, water stress, and salinity stress resilience.***
- ✓ Yield in tons per hectare was 27.1% higher with KPCB and 40% water stress, vs. 6% higher yield with KPCB and no water stress.
- ✓ Grain Yield per hectare was 4.3% higher with KPCB and 40% water stress. Additionally, the researchers found 4.4% HIGHER GRAIN DENSITY with KPCB and 40% water stress.
- ✓ The researchers calculated that profitability of biomass production vs. water use was 1% better with KPCB without water reduction. In contrast, when using KPCB with 40% water stress the **profitability** of biomass production was boosted by 20%. The **Agronomic Water Use Efficiency** was 20% better with KPCB and 40% water stress, vs. 6% better with KPCB and no water stress.
- ✓ We highly recommend further study into water stress boost with KPCB, using our POPS – Profitability Optimization for Sustainability, to find the precise "Sweet spot" of maize sustainability in Morocco.

Glossary

- D.A.S, DAS: Days After Seeding
- DNM: Readily Available Water
- ENA: in French, École Nationale d'Agriculture – National School of Agriculture, in Meknès, Morocco
- ETc: Crop Evapotranspiration – the amount of water a crop needs.
- ETo: The reference evapotranspiration, which is the evapotranspiration of a reference crop.
- EWUE: Economical Water Use Efficiency
- f: crop-specific coefficient
- FAO 56: the standard method for computing water requirement of irrigated crops [Allen et al, 1988, https://appgeodb.nancy.inra.fr/biljou/pdf/Allen_FAO1998.pdf]
- FC: Field Capacity
- GDU: Growing Degree units
- Hcf: field capacity
- Hpfp (H_{pfp}): permanent wilting point humidity
- K0: no Kyminasi
- K1: with Kyminasi
- Kc: The crop coefficient, which is a value that takes into account the crop's attributes and how it's managed.
- MAD: Moroccan Dirham
- n.s: no significant effect
- NSE: No Significant Effect
- NB: number
- Psh (Phs): % of soil humidity
- PWP: Permanent Wilting Point
- Rd: Root depth
- RFU: readily usable reserve (in this study, in millimeters of water)
- T (Tmin, Tmax): temperature (in this study, in degrees Celsius)
- WUE: Water Use Efficiency
- *: there is a significant effect