Effects of electromagnetic irrigation water on lagos spinach evapotranspiration using lysimetric method

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Abstract: The study was conducted to determine the effect of magnetic treatment of water on the evapotranspiration of lagos spinach – simply called celosia, at different growing stages up until harvest, with varying magnetic flux densities and non – magnetic water as the control experiment. Flux densities of T_1 = 719 G using 12 V terminal, T_2 = 443 G using 8 V terminal, T_3 = 319 G using 6 V, T_4 = 124 G using 4 V and T_5 = 0 G (control) obtained from the electromagnet, were used in treating irrigation water. Equal volume of water (1.3 litres) was used to irrigate the plants every irrigation session. Each treatment was replicated ten times to make a total number of 50 buckets of celosia plants laid out in a completely randomized design (CRD) layout. Celosia seeds were planted in the 50 buckets in a transparent screenhouse for 42 days (08-May-2018 to 18 - June – 2018). Lysimetric method was used to compute water lost due to evapotranspiration per day by weight loss in buckets. The mean values of daily evapotranspiration of two celosia plants per bucket over a – 42 – day period of growth for T_1, T_2, T_3, T_4 and T_5 were 7.49 mm day^{-1}, 7.55 mm day^{-1}, 7.76 mm day^{-1}, 8.36 mm day^{-1} and 7.68 mm day^{-1} respectively. Daily values of evapotranspiration subjected to the analysis of variance (ANOVA) at a confidence interval of 95% (i.e. $\alpha \leq 0.05$) using the IBM Statistical Package for Social Science Students version 22 (SPSS) showed that the rate of water absorption by celosia plants for evapotranspiration was statistically significant. The percentage increment of evapotranspiration of celosia irrigated with magnetic water compared with that of ordinary water varied from 1.04% to 8.85%. This implies that magnetically – treated celosia plants absorbed water more easily than those of ordinary water, and this might be responsible for the former's enhanced growth by 19.26%.

Keywords: celosia, electromagnet, evapotranspiration, irrigation, screenhouse, lysimetric method, magnetically-treated.

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1 Introduction

Magnetic water or magnetized water or magnetically - treated water is interchangeably used as a term for water that has passed through magnetic field, which can be used for agriculture, especially for crop and animal improvements (Maheshwari and Grewal, 2009). Several applications can be obtained from the effect of magnetic field in agriculture. Kronenberg (1993) discovered that magnetic field actually changed the nucleus of water, reduced the surface tension of water and softens water. Water with a low surface tension can penetrate deeper through the soil, which has more solubility to dissolve plant minerals in the soil, and magnetized water with dissolved plant nutrients can easily be absorbed by crop, thereby increasing crop yield. According to Babu (2010), water molecules are usually arranged in haphazard form before magnetization but after magnetization. The molecules line up in sequence and can be easily absorbed by plants. Magnetically – treated water usually induces the reduction in surface tension, reduces viscosity, increases permeability, increases dissolvability and increases oxygen content, thereby availing the plants with

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sufficient nutrients. Amaya et al. (1996) and Podsleny et al. (2004) reported that an optimal external electromagnetic field accelerated the plant growth, especially seed germination percentage and speed of emergence. Lysimeters are generally employed when vegetation is grown in a large soil tank which allows the rainfall input and water lost through the soil to be easily calculated.

In Nigeria, the demand for lagos spinach as a vegetable has not been considerably met by its supply owing to the fact that, a large percentage of its production is done in the rural areas where proper knowledge of its water use requirement is deficient. Therefore, there was a need to consider an eco-friendly magnetic treatment of irrigation water to enhance consumptive use of lagos spinach and study its computation by lysimetric method. Thus, the aim of this study was to determine the effects of magnetic treatment of water on evapotranspiration of lagos spinach by direct (lysimetric) method.

2 Materials and methods

2.1 Experimental sites

This study was conducted in a screenhouse erected on the research farmland of the Department of Agricultural and Biosystems Engineering, University of Ilorin, Ilorin, Kwara State, Nigeria. Ilorin is geographically located on the latitude $8^{\circ}30^{\prime}$N and longitude $4^{\circ}35^{\prime}$E, at an elevation of about 340 m above mean sea level (Ejieji and Adeniran, 2009). Ilorin is located in the Southern Guinea Savannah Ecological zone of Nigeria, and experiences an annual rainfall of about 1300 mm. The wet season begins from the end of March and ends in October, while the dry season starts in November and ends in March (Ogunlela, 2001). The study was carried out from 08 – May – 2018 to 17 – June – 2018 with a total number of 50 buckets.

2.2 Soil characteristics

The values of ET_c, Θ_{aw}, d_n, I_v and V_{daily} determined at K_c = 1.05 were 4.39 mm day^{-1}, 43.15 mm m^{-1}, 12.95 mm, 2 days and 1.3 *l*/ 2 plants/ 2days respectively. Irrigation was done when 30% Θ_{aw} was depleted. Field capacity Θ_{fc} was estimated to be 27.73% at a Wilting point Θ_{wp} = 12.60% with soil bulk density ρ_b = 1.24 g cm^{-3}. The percentage contents of clay, sand and silt of the soil used was 7.52%, 84.01% and 8.76% respectively and the soil was categorised as loamy sand. Table 1 shows average physical and chemical properties of the soil used.

Table 1 Physical and chemical properties of soil used for planting celosia

Properties	Composition
Sand (%)	84.01
Silt (%)	8.76
Clay (%)	7.52
Gravel (%)	Nil
pH in water (1:1)	5.8
Organic carbon (%)	0.97
Organic matter (%)	1.30
Total nitrogen	1.3
Exchangeable adsorption ratio	11.56
Available phosphorus (mg kg^{-1})	1.30
Ca^{2+} (cmol kg^{-1})	1.35
Mg^{2+} (cmol kg^{-1})	0.74
Na^{+} (cmol kg^{-1})	1.20
K^{+} (cmol kg^{-1})	2.30

2.3 Water irrigation magnetic procedure

The irrigation water was allowed to pass through three electromagnetic chambers twice for a duration of 930 s in a circulation flow method so as to ensure effective magnetic treatment of the water (Aladjadjiyan, 2007; Chern, 2012). The water was immediately used to irrigate the plants according to the treatment while observing the ‘memory effect’ of magnetic treatment of water.

2.4 Treatment and statistical design

Celosia argentae seeds (40 g) were procured from National Horticultural Institute of Nigeria (NIHORT), Ibadan and were broadcast into 50 buckets on 08 – May – 2018. The buckets were arranged in a Completely Randomized Design layout and irrigated with wastewater obtained from downstream of University of Ilorin dam according to treatment. Five treatments of different magnetic flux densities i.e. T_1 = 719 G, T_2 = 443 G, T_3 = 319 G, T_4 = 124 G and T_5 = 0 G (control) were replicated ten times to eliminate error as a result of insufficient data.

2.5 Light transmission potential of transparent poly cover for the screenhouse

A 6 m × 4 m × 2 m low-cost screenhouse was constructed on the selected farmland. A transparent 200 micron UV- treated poly cover was installed all over the screenhouse structure to obtain a fully controlled condition. The poly cover ran from 0.5 m above the ground to the top of the garden shed.

The light transmitted through the poly cover was measured with the use of an Extech digital light meter (model no. LT300). At an interval of 15 minutes (2:00, 2:15, 2:30, 2:45 and 3: 00 pm), readings were obtained at four different locations (indicating the four sides of the screenhouse) within and outside the screenhouse. Average light transmittance, efficiency of poly cover in transmitting light into the garden shed, photosynthetic active radiation (PAR) and daylight index (DLI) were determined from Equations 1-4 respectively. Table 2 shows the mean values obtained from light transmittance tests performed on 26 – 05 – 2018 and 29 – 05 – 2018.

$$T_{\lambda a} = \frac{I_t}{I_i} \times 100 \quad (1)$$

$$E_{LT} = \frac{T_{\lambda a}}{T_{RT}} \times 100 \quad (2)$$

$$PAR = \frac{L_M}{5} \quad (3)$$

$$DLI = \frac{24 \times 3600 \times PAR}{10^6} \quad (4)$$

where:

$T_{\lambda a}$ = average light transmittance (%); I_t = transmitted light intensity (fc h^{-1}). I_i = incident light intensity (fc h^{-1}); E_{LT} = light transmission efficiency of poly cover (%); T_{RT} = required transmittance of poly cover (%); PAR= Photosynthetic Active Radiation (mmol m^{-2} s^{-1}); DLI = Daylight Index (mol m^{-2} d^{-1}); and L_M = average luminance from digital light meter inside the garden shed or outside the shed (fc h^{-1}).

Mean value for luminance outside the screenhouse (4750 fc h^{-1}) was greater than mean value of luminance inside (3720 fc h^{-1}) the screenhouse. These two values were slightly lesser than the standard value of luminance requirement (5000 fc h^{-1}) of vegetables as recommended by Giacomelli et al. (1990). The variation could be as a result of spatial and environmental differences in daylight radiation of Giacomelli's location and the study area. In a word, climatological data varied spatially and temporally over locations.

Mean values of PAR and DLI for outside shed were 950.1 mmol m^{-2} s^{-1} and 82.09 mol m^{-2} d^{-1} respectively and were found to be greater than those obtained in the screenhouse i.e. PAR = 744.2 mmol m^{-2} s^{-1} and DLI = 64.30 mol m^{-2} d^{-1}. These values obtained in the screenhouse were found to be sufficient for the optimal growth of celosia as reported by Giacomelli et al. (1990). Table 2 shows mean values of light transmission inside and outside the screenhouse for two days.

Table 2 Average values of light transmission on 26 – 5 – 2018 and 29 – 5 -2018

Time	Outside shed			Inside shed			Average light transmittance, T_{la}	Efficiency of transmission, ELT (%)
	Luminance (Kfc h^{-1})	PAR (mmol m^{-2} s^{-1})	DLI (mol m^{-2} d^{-1})	Luminance (Kfc h^{-1})	PAR (mmol m^{-2} s^{-1})	DLI (mol m^{-2} d^{-1})		
2:00 PM	5.49	1098	94.85	3.91	780.8	67.46	71.74	84.4
2:15 PM	5.27	1053	90.98	4.31	861.3	74.42	80.77	95.02
2:30 PM	5.09	1017	87.87	4.09	816.8	70.57	79.57	93.61
2:45 PM	5.11	1021	88.22	4.07	813.8	70.31	78.73	92.62
3: 00PM	2.81	561.5	48.51	2.24	448.3	38.73	78.71	92.6
Mean	**4.75**	**950.1**	**82.09**	**3.72**	**744.2**	**64.30**	**77.90**	**91.65**

Note: fc (1 lumen/ft^2) = 10.76 lux, 1 Kfc h^{-1} = 1000 fc h^{-1}

2.6 Weather data

Agro – climatological data such as maximum and minimum temperature, wet and dry bulb temperature, wind speed, wind direction and humidity were remotely – sensed within the screenhouse using an Oregon Scientific Pro Weather Station (Model WMR86A), which comprised a wireless Base Station Receiver, a Wind Sensor with a cup counter anemometer and a Temperature / Humidity Sensor, in such a way that weather data were transmitted wirelessly within a range of 100 metres. Calibration of values obtained at first was done against weather data obtained from other instruments within a nearby meteorological station and found to agree significantly. Two Evaporation Pans (one pan inside the screenhouse and the other outside in the Agricultural and Biosystems Engineering Meteorological Station) were set up to quantify the amount of moisture lost to the atmosphere via evaporation and transpiration. Weather data were recorded at 8 a.m. and 4 p.m. daily. Two non - recording raingauges were installed in the nearby meteorological station – which was representative of the external environment of the screenhouse to measure the amount of precipitation. Figure 1 shows the site instrumentation on the experimental site layout.

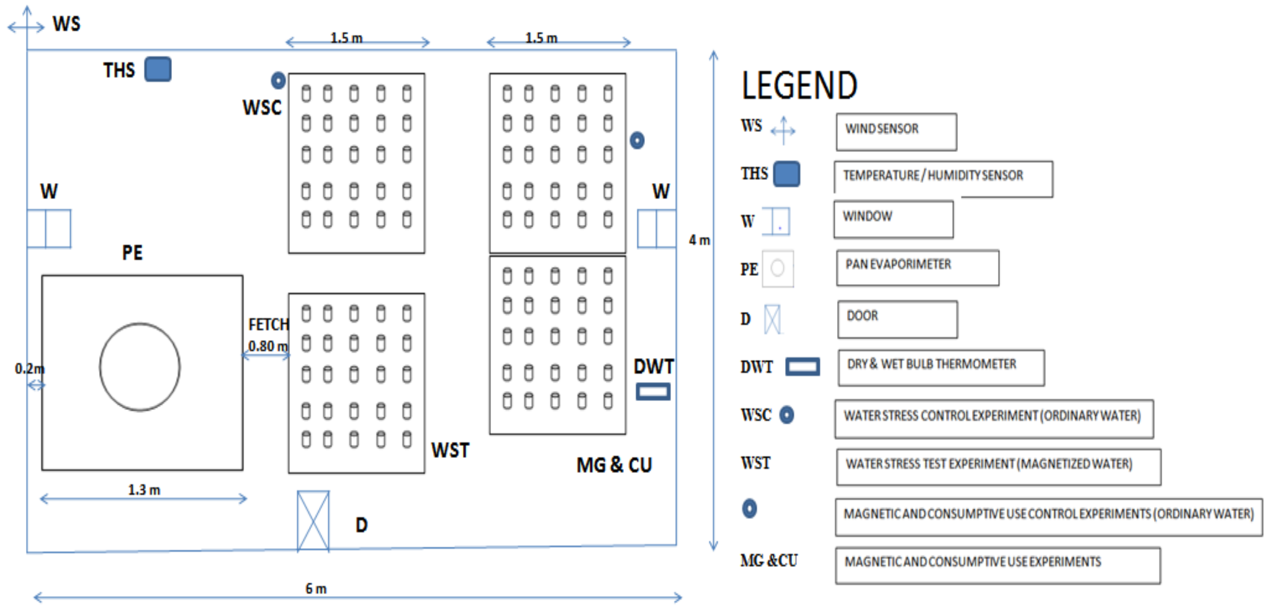

Figure 1 Site instrumentation

2.7 Meteorological data during the study

Temperature values within the screenhouse were always significantly higher than those outside the study area. Temperature values within the screenhouse ranged from 22.7°C to 28.4°C (wet and dry) at 9 a.m. while outside the screenhouse, a temperature range of 23.3°C to 27°C at 9 a.m. was recorded. Temperature values ranged from 27.9°C to 32.4°C at 4 p.m. within the shed while it was 25.7°C to 29.9°C outside the shed. Weekly minimum and maximum temperature values within the screenhouse ranged from 26.7°C to 33.3°C respectively, while outside the site, it was 23.4°C to 32°C respectively. The duration was characterized with a significant level of cold spell.

Average weekly humidity values within the screenhouse ranged from 54.0% to 64.3% while outside the screenhouse, it was 47.4% to 56.6%. Humidity values within the screenhouse were considerably higher than those obtained outside the area in the morning but in the afternoon, when the shed heated up more than the external environment, humidity dropped considerably. Average weekly wind run ranged from 91.6 km day^{-1} to 169.9 km day^{-1} and the direction was mostly towards southwest (probably owing to the location and orientation of the shed). The highest average weekly depth of water evaporated from the screened evaporimeter was 4.7 mm at 6 WAP while that of unscreened was 8.6 mm correspondingly. The lowest average weekly depth of water lost by the screened evaporimeter was 2.1 mm at 1 WAP but that of unscreened pan was 4.1 at 2 WAP. Highest weekly amount of rainfall was recorded at 1 WAP with a value of 39.9 mm (average taken from two 5- inch raingauges installed 1.6 m apart) while lowest value was recorded at 3 WAP with a value of 11.2 mm of rainfall. There was no rainfall throughout the second week and sixth week.

2.8 Measurements

2.8.1 Mass and volume of water lost due to evapotranspiration

The experiment comprised five treatments replicated ten times to achieve more precise results and eliminate errors due to the lesser sample size. Buckets of plants with smaller bowls placed underneath were weighed before every irrigation and reweighed immediately after irrigation before rapid percolation set in. Change in weight was computed through the lysimetric approach to account for water loss solely due to evapotranspiration and for plants’ metabolism. The volume of water lost due to evapotranspiration was calculated from the mass of water lost to the atmosphere from the bucket containing the soil and celosia plant. This was determined from Equation 6 derived from Equation 5.

$$V_w = \frac{m_w}{\rho_w} \quad (5)$$

$$V_{wl} = m_w \quad (6)$$

where: ρ_w is the density of water (kg m^{-3}), m_w is mass of water lost due to ET (kg), V_w is the volume of water lost from the bucket (m^3) and V_{wl} is volume of water lost (*l*). An example of volume of water lost due to evapotranspiration was presented below and it showed that mass of water lost from each bucket of celosia in kg was the same as volume of water lost from the particular bucket in litres.

$$V_w = \frac{0.53\ kg}{1000\ kg/m^3} = 5.3\ \times 10^{-4}\ m^3,$$

$$V_{wl} = 5.3\ \times 10^{-4}\ m^3 \equiv 0.53\ litres$$

2.8.2 Evapotranspiration from mass of water lost

Evapotranspiration of celosia argentae (mm day^{-1}) due to the mass of water lost to the atmosphere was computed using Equation 7. An example was presented as shown in the following expression when values of V_{wl} and A_b were 0.4133 *l* and 0.071 m^2 respectively. Results of mean values of ET_c and volume or mass of water lost were shown in Table 3.

$$ET_c = \frac{V_{wl}}{A_b} \tag{7}$$

$$= \frac{0.4133\ l/day}{0.071\ m^2} =$$

$$5.82\ mm\ day^{-1}\ \ for\ two\ stands\ of\ celosia\ per\ bucket$$

2.8.3 Reference crop evapotranspiration

Consumptive use experiment was performed by placing smaller bowls of 40g each under each bucket to collect drainage water. Each bucket of soil was weighed with the bowl before and after every irrigation session. Germination was observed after 4 days of planting. Thinning and transplanting to two plants per bucket were done two weeks after planting (2 WAP) to establish growth uniformity. Reference crop evapotranspiration, ET_o was generated by CROPWAT 8.0 model using agro – climatological data obtained from the CLIMWAT database for Ilorin weather station (Station 2837), by the FAO Penman Monteith method as illustrated in Equation 8 by Smith et al. (1992).

$$ET_o = \frac{0.408\,\Delta\,(R_n - G) + Y\frac{900}{T+273}U_2(e_a - e_d)}{\Delta + Y\,(1 + 0.34U_2)} \tag{8}$$

where:

ET_o= reference crop evapotranspiration (mm day^{-1}); R_n = net radiation at crop surface (MJ m^{-2} day^{-1}); G = soil heat flux (MJ m^{-2} day^{-1}); T= average temperature at 2 m height (^oC); (e_a - e_d)= vapour pressure deficit for measurement at 2 m height (KPa); U_2=wind speed at 2 m height (m s^{-1}); Δ= slope of vapour pressure curve (KPa ^oC); Y= psychometric constant (KPa ^oC); 900= coefficient for the reference crop (KJ Kg day^{-1}); 0.34= wind coefficient for the reference crop (S m^{-1}).

Crop evapotranspiration (ET_c) values of celosia, available water, net depth of irrigation, irrigation interval and volume of water required daily by celosia were determined using Equations 9-13 respectively.

$$ET_c = ET_o \text{ x } K_c \tag{9}$$

$$\Theta_{aw} = \frac{\rho_b}{\rho_w}\frac{(\Theta_{fc} - \Theta_{wp})D_{rz}}{100} \tag{10}$$

$$d_n = P_n \times \Theta_{aw} \tag{11}$$

$$I_v = \frac{d_n}{ET_c} \tag{12}$$

$$V_{daily} = ET_{peak} \times C_{c_{end}} \times A_b \tag{13}$$

where:

ET_c= crop evapotranspiration (mm day^{-1}); ET_o= reference crop evapotranspiration (mm day^{-1}); K_c= crop coefficient. Θ_{aw} = available water (%); ρ_b = bulk density (g cm^{-3}); ρ_w = density of water = 1 g cm^{-3}; D_{rz} = effective rooting depth of celosia (mm), d_n = net depth of irrigation (mm), Θ_{fc} = moisture content at field capacity (%), Θ_{wp} = moisture content at wilting point(%), P_n is the percentage of available water depletion at which irrigation must be supplied before wilting point (in fraction), I_v = irrigation interval (days); d_n = net depth of irrigation (mm) and ET_{peak} = peak crop evapotranspiration of the crop (mm day^{-1}). $C_{c\ end}$ = canopy cover coefficient of celosia at late stage, A_b= Area of bucket = 0.071 m^2.

For the first two weeks, crop coefficient, K_c value provided by CROPWAT 8.0 was 0.7 with a canopy cover coefficient of 40%. Thinning of plants to two plants per bucket was done after two weeks of planting (2 WAP). During the developmental stage, (i.e. from 2 weeks to 4 weeks), canopy cover coefficient increased to 80%, thereby creating more shade and immediately after this period, mid – season set in with a canopy coefficient of 100%. It was assumed that, at this period, celosia plants had completely shaded the ground and plants could be harvested after a week since the study was focused on analysing celosia for leaf and biomass. This was in accordance with the work of Ewemoje and Majekodunmi (2008) that optimum biomass yield of celosia was achieved between 4 – 5 weeks after planting (i.e. 4-5

WAP). Local farmers within the area of study also asserted that harvest of celosia plants was best at 4 – 5 WAP.

3 Results and discussion

Consumptive use (CU) was slightly higher for magnetically – treated water as shown in Table 3. The mean values of daily evapotranspiration of two celosia plants per bucket over a – 42 – day period of growth for T1 (719 G), T2 (443 G), T3 (319 G), T4 (124 G) and T5 (ordinary) were 7.49 mm day^{-1}, 7.55 mm day^{-1}, 7.76 mm day^{-1}, 8.36 mm day^{-1} and 7.68 mm day^{-1} respectively, as indicated in Figure 2. The graph shows that T4 (124 G i.e. lowest flux density) produced the highest evapotranspiration demand of two celosia plants i.e. 8.36 mm day^{-1}, followed by T3 (319 G) i.e. 7.76 mm day^{-1} and T5 (control) i.e. 7.68 mm day^{-1}. The percentage increment of ET of celosia irrigated with magnetic water compared with that of ordinary water varied from 1.04% to 8.85%. This implies that magnetically – treated celosia plants absorbed water easily than those of ordinary water, and this might be responsible for the former's enhanced growth. This was in accordance with the work of Babu (2010) and Dhawi (2014) that magnetic water softened and enhanced water structure by increasing its solubility, thereby making more water available for plant metabolism and use. Table 4 shows the mean values of mass of water lost due to evapotranspiration (ET) and daily computed ET values of celosia plants for 42 days (two stands of celosia per bucket).

Table 3 Mean values of mass of water lost due to evapotranspiration (ET) and daily ET of celosia plants for 42 days (two stands per bucket)

Irri No	Date	Mass of water lost due to ET (kg day^{-1}=*l* day^{-1})					Computed ET of celosia for two stands per bucket (mm day^{-1})				
		T1	T2	T3	T4	T5	T1	T2	T3	T4	T5
1	11-14/5/2018	0.413	0.417	0.447	0.530	0.427	5.82	5.87	6.30	7.46	6.01
2	15-18/5/2018	0.427	0.443	0.457	0.527	0.437	6.01	6.24	6.44	7.42	6.15
3	19-22/5/2018	0.447	0.453	0.460	0.533	0.457	6.30	6.38	6.48	7.51	6.44
4	23-24/5/2018	0.455	0.467	0.480	0.545	0.470	6.41	6.58	6.76	7.68	6.62
5	25-26/5/208	0.470	0.475	0.470	0.555	0.480	6.62	6.69	6.62	7.82	6.76
6	27-28/5/2018	0.472	0.480	0.470	0.535	0.490	6.65	6.76	6.62	7.54	6.90
7	29-30/5/2018	0.480	0.485	0.525	0.550	0.495	6.76	6.83	7.39	7.75	6.97
8	31-1/6/2018	0.515	0.520	0.510	0.570	0.530	7.25	7.32	7.18	8.03	7.46
9	2-3/6/2018	0.530	0.540	0.565	0.585	0.550	7.46	7.61	7.96	8.24	7.75
10	4-5/06/2018	0.570	0.575	0.585	0.615	0.580	8.03	8.10	8.24	8.66	8.17
11	6-7/06/2018	0.580	0.575	0.600	0.620	0.590	8.17	8.10	8.45	8.73	8.31
12	8-9/06/2018	0.600	0.605	0.625	0.640	0.620	8.45	8.52	8.80	9.01	8.73
13	10-11/06/18	0.610	0.615	0.630	0.645	0.635	8.59	8.66	8.87	9.08	8.94
14	12-13/06/18	0.635	0.630	0.650	0.655	0.635	8.94	8.87	9.15	9.23	8.94
15	14-15/06/2018	0.640	0.645	0.660	0.680	0.640	9.01	9.08	9.30	9.58	9.01
16	16-17/06/2018	0.660	0.650	0.680	0.715	0.685	9.30	9.15	9.58	10.07	9.65
Mean		**0.532**	**0.536**	**0.551**	**0.594**	**0.545**	**7.49**	**7.55**	**7.76**	**8.36**	**7.68**

Note: T1 = magnetic water treated with 719 G; T2 = magnetic water treated with 443 G; T3 = magnetic water treated with 319 G; T4 = magnetic water treated with 124 G and T5 = untreated water (ordinary water as control).

Values of evapotranspiration subjected to analysis of variance (ANOVA) at a confidence interval of 95% (i.e. $\alpha \leq 0.05$) using the IBM Statistical Package for Social Science Students version 22 (SPSS) and found that, the rate of water absorption by celosia plants for evapotranspiration was statistically significant as indicated in Table 4.

Also, analysis of 25 buckets of celosia (at 6 WAP), showed that magnetic treatment of water increased the rate of vegetative growth and bulk weight of celosia plants when compared with plants irrigated with ordinary water. Mean bulk weight (BW) and edible weight (EW) of celosia were the highest under the treatment with the highest magnetic flux density T1 (719 G) (i.e. 172.72 g and 133.48 g respectively), when compared with the other four treatments of 443 G, 319 G, 124 G and ordinary water (i.e. 158.08 g and 124.22 g respectively) as explained in Figure 3. This may be attributed to higher water content in the edible parts of the vegetable crop induced by hydrogen bond breakage, increased solubility and reduced surface tension as a result of magnetic treatment and this submission agreed with the findings of

Qados and Hozayn (2010). Also, this may be explained with the submission of Dhawi (2014) that, magnetic treatment of water may act as a plant hormone like Auxin in plant system that could improve vegetative growth or accelerate enzymes related to Auxin reactions. Figure 4 shows a picture of celosia plants at 3 weeks after planting (3 WAP).

Table 4 ANOVA of crop evapotranspiration

	Sum of squares	df	Mean square	F	Sig.
Treatment	7.858	4	1.965	1.643	.017*
Error	89.702	75	1.196		
Total	97.560	79			

Note: * significant at P ≤ 0.05

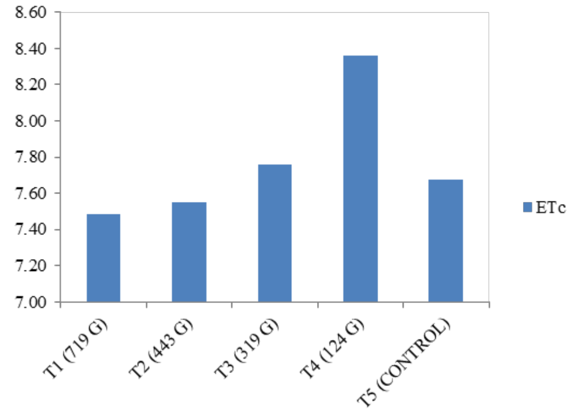

Figure 2 Mean daily evapotranspiration of two stands of celosia plants per bucket over a period of 42 days

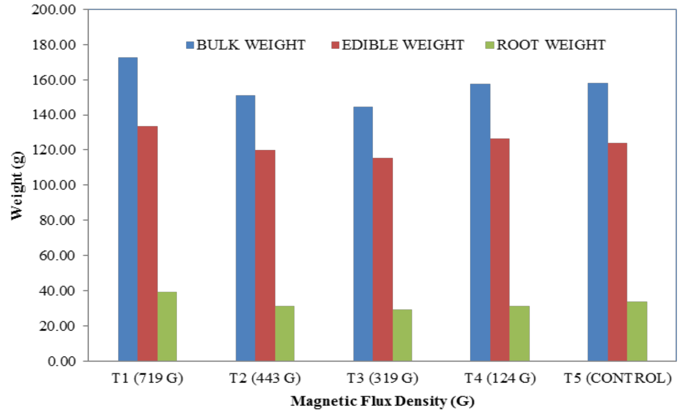

Figure 3 Mean fresh weight of celosia plants at 6 WAP

Figure 4 Celosia growth at 3 WAP

4 Conclusion

Magnetic treatment of irrigation water increased the evapotranspiration demand of two stands of celosia plant per bucket by 8.85%, thereby increasing its vegetative and fresh yield per bucket by 19.26%.

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