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IMPACT OF STATIONARY MAGNETS AS IRRIGATION WATER SOFTENER FOR SUSTAINABLE COWPEA PRODUCTION

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ABSTRACT
Magnetic irrigation water was studied at the research farm in Kwara State University, Malete on the growth and yield of cowpea cultivar TVX-117 under transparent garden. Water was passed through 112.74mT magnetic flux twice and ordinary water served as control treatment. Cowpea seeds were planted in buckets replicated 10 times using Randomized Complete Block Design (RCBD). Irrigation interval of 3-day and 1.50 litres of water as volume of water required for two stands of cowpea were experimented. Magnetic fields changed the physicochemical properties of water and results obtained indicated significant differences in seeds germination, crop height, stem diameter and cowpea yield compared to control treatment of non-magnetized irrigation water at P<0.05 significant level. Magnetic agriculture is environmentally friendly, no health implications on consumption of produce and reduces cost of production.

Keywords: *Cowpea, Magnetized water, Neodymium, Transparent garden, Water softener*

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INTRODUCTION

Cowpea (*Vigna unguiculata L. Walp*.) is an ancient human food since Neolithic history grown majorly as food, animal feeds, source of income and manure. It is important legume crop originated from Sub-Saharan Africa for its dry seeds, green pods, green seeds and fresh tender green leaves as vegetable (Ortiz,1998; Agyeman *et al.*,2014). Cowpeas contain nutrients such as protein, fat, fibre, carbohydrate, thiamine, riboflavin and niacin at varying percentages based on the cultivars (Davis *et al*., 1991). Research work had been carried out on various methods of improving crop production apart from application of inorganic fertilizers such as bio-stimulation of seeds and induction of irrigation water through sun light, ultraviolet light, electrical and magnetic fields (Elfadil and Abdallah, 2013).Magnetic process could be achieved by electromagnetic induction or through stationary permanent magnets. Electromagnetic induction treatment exhibited much heat and costly for local farmers.

Water is paramagnetic that lost its charges through transportation along the pipe but treating irrigation water with magnetic fields restored the energy (Elfadil and Abdallah, 2013). Magnetized water dissolved more nutrients thereby plant required less fertilizer and healthier to sustain pest and diseases (Zhang *et al*., 2009). Elimination of chemicals reduced production cost and sustained environmental health (Shoeb *et al*., 2004). Magnetic treated water reduced surface tension and acidity (Huang and Bie, 2010). Hozayn and Abdul Qados (2010) reported that magnetic fields influenced germination of seeds, plant growth and development, ripening of fruits and vegetables as well as crop yield. There were controversial arguments made by early researchers based on their experimental results.

There was a significant improvement in water absorption of lettuce seeds treated magnetically that resulted to increase germination percentage (Reina *et al*., 2001). Grewal and Maheshwari (2011) concluded that magnetic treated water (MTW) was more productive than magnetic treated seeds (MTS) for seedling emergence and performance. This research studied the effects of magnetically treated water on agronomic characteristics of TVX-117 cowpea cultivar against ordinary water.

MATERIALS AND METHODS

Study Area

The study area is the research farm of the Food and Agricultural Engineering Department, Kwara State University Malete, Moro Local Government Area of Kwara State, Nigeria (Figure 1). Malete town is part of Ilorin Emirate which is 27km from Ilorin located between Latitude 8°42`0``N and Longitude 4°28`0``E. The annual rainfall ranges between 1000mm to 1500mm. The elevation varies from 273m to 364m above sea level and the temperature ranges between 25°C and 30°C in the wet season while it ranges between 33°C to 34°C in the dry season. In order to protect cowpea plants from rainfall, a transparent shed covered with polyethylene was constructed with dimensions 9.0m long, 7.0m wide, 4.0m high from the ground surface.

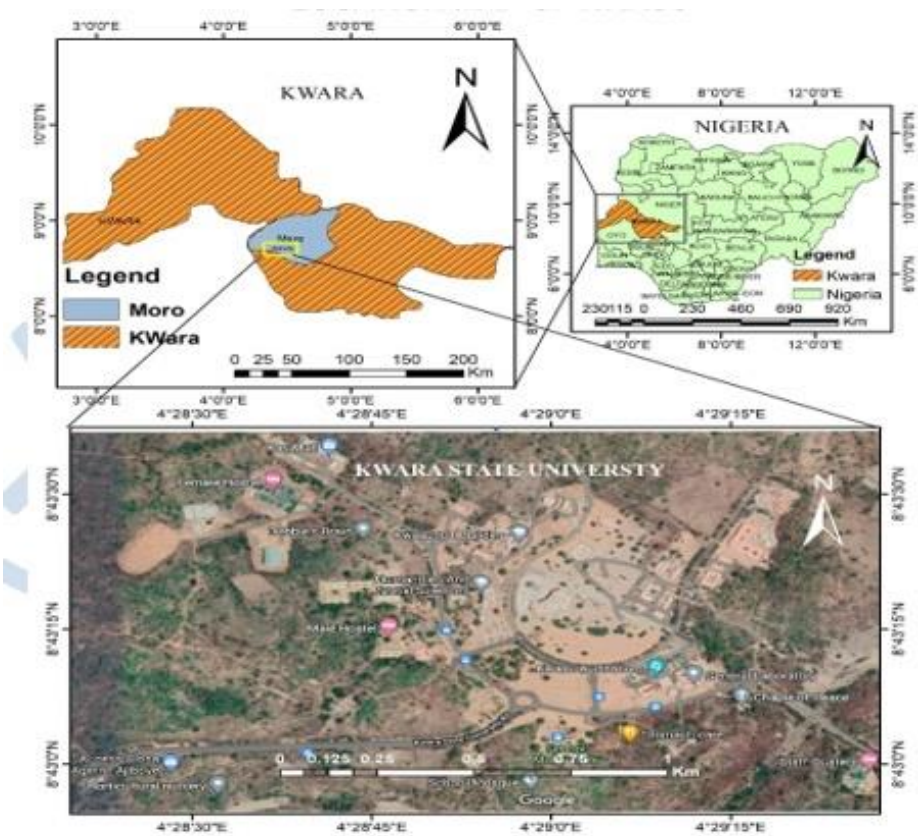

Figure 1: Map of KWASU study area

Magnetic Irrigation Water Treatment

The investigation of magnetized and ordinary water on the agronomic characteristics of TVX-117 cowpea was studied under transparent garden. Magnetic water was obtained by passing water through magnetic fields of neodymium magnets within the treatment chamber as shown in Figure 2. Magnetic fields were produced within the chamber using twelve pairs of neodymium magnets (N50 grade, 50mmx25mmx10mm); each magnet weighed 84.5gram fixed to a metal frame with 45mm distance between pairs and 20mm to the two edges. The magnetic flux densities at the outlet measured by digital magnetic gauss meter model TD 8620 was 112.74mT or 1127.4G. The mean flow rate for two runs of water treatment was 2.86 litres/minute.

Figure 2: Magnetic water treatment

Experimental Design

A randomized complete block design (RCBD) experiment was used with ten replications. A pot experiment involved two irrigation treatments (magnetically treated water – MTW) and (non-magnetically treated water or control treatment – NMTW) under transparent garden and cowpea seeds of TVX-117 varieties. The cowpea seeds obtained from the Faculty of Agriculture grain reserve section, Kwara State University. The initial moisture content of the seeds was 7.2% determined by using seed moisture meter KT100S with measuring range of 5-35%.

Cowpea seeds were planted at three seeds per bucket but thinned to two after 10 days after planting (DAP). Irrigation interval of 3-day and 1.50 litres volume of water required by two cowpea plants were obtained using equations 1, 2, 3 and 4 as reported by Yusuf and Ogunlela (2015).

$$ET_c = K_c \times ET_o \ldots\ldots\ldots\ldots [1]$$
$$V_{dp} = K_c \times ET_o \times C_c \times A_{p} \ldots [2]$$
$$I_v = \frac{d_n}{ET_c} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots [3]$$
$$V_{days} = V_{dp} \times N_p \times I_v \ldots\ldots [4]$$

Cowpea growth parameters (germination indices, plant height, stem thickness) and yield were recorded.

RESULTS

Influence of Magnetic Fields on Water Properties

The chemical properties of magnetized and non-magnetized water were significantly different as shown in Table 1. The anions and cations were increased after magnetization compared to ordinary water. Electrical conductivity (EC), viscosity and pH except total hardness of the magnetically treated water were higher than ordinary water.

Effect of Magnetized Water on Germination of Cowpea

Table 2 shows the germination of seeds recorded after three days of planting (DAP) for the two treatments; magnetic treated water (MTW) and control treatment (NMTW). Germination count at fourth day after planting indicated that magnetic water treatments produced more than treatment with germination of the control treatments. The seedlings emergence throughout the germination period showed that magnetized treatments were more than the control treatments. Germination of cowpea seedlings of MTW was significantly ($P<0.05$) higher than the control treatment using analysis of variance. Treatments involved magnetized irrigation (MTW) had 51% germination percentages more than non-magnetized irrigation water (NMTW).

Effect of Magnetized Water on Crop Agronomic Development

Cowpea seedlings growth parameters examined were crop height, stem diameter and yield.

Crop Height and Stem Diameter

The cowpea plant height shows that magnetic treatment possessed better crop heights at 20, 35 and 65 DAP compared to control that had the lowest plant height as shown in Table 3.

Cowpea Yield

The mean cowpea yields obtained for the treatments showed that magnetized water treatment using neodymium magnets had the highest yield at 56% more than the control treatment as shown in Table 5. Statistical analysis using one sample t-test indicated that there was significant ($P<0.05$) difference at $P=0.0006$ and coefficient of determination R^2 value of 0.9599 on cowpea yield under magnetic and non-magnetic treatments.

Table 1: Chemical compositions of magnetically treated and ordinary water

Parameters	Magnetized water	Non-treated water	Units
Calcium	42	10	Mg/L
Magnesium	50	26	Mg/L
Potassium	21	11	Mg/L
Na	1.28	0.96	Mg/L
Pb	0.01	0.01	Mg/L
Chromium	0.14	0.07	Mg/L
P	0.84	1.35	Mg/L
CO_3^{2-}	32	10	Mg/L
SO_4^{2-}	17	8	Mg/L
$N(NO_3^-)$	6.8	3.9	Mg/L
Chlorine	36	26	Mg/L
pH	6.38	5.10	-
EC	170.8	165.4	µs/cm
Viscosity	3300	2650	Mpa.s
Total Hardness	16	60	Mg/L

Table 2: Record of Mean Cowpea Germination

Treatments	Germination DAY 4	Germination DAY 5	Germination DAY 6	Germination DAY 7	Mean
MTW	25	41	47	47	40.0
NMTW (Control)	11	19	24	24	19.5
Total	36	60	71	71	

MTW-Magnetic Treated Water *NMTW-Non-Magnetized Water*

Table 3: Cowpea development under magnetic and non-magnetic irrigation water

Treatments	Days after planting	Plant height (cm)	Leaf length (cm)	Leaf breadth (cm)	Leaf Area (cm^2)	No of Leaf/plant
MTW	**20**	15.7	5.17	2.67	13.80	6
NMTW		16.0	5.60	2.30	12.88	7
MTW	**35**	41.3	6.50	3.73	24.25	20
NMTW		38.0	6.37	2.67	17.00	17
MTW	**65**	68.3	7.43	3.97	29.50	32
NMTW		56.3	6.70	3.30	22.11	28

Table 4: Table Showing Mean Diameter of the Cowpea Stems, Measured 25mm above the Soil Level at 65 Days After Planting (DAP).

Date	Stem diameter (cm)				
	T1	**T2**	**T3**	**T4**	**Tc**
23/04/2020	0.773	0.803	0.740	0.801	0.630

Table 5: Mean Cowpea Yields under Magnetic and Non-magnetic Treatments.

Treatments	MTW	NMTW
Total yield(g)	133	58
Mean yield(g)	13.3	5.8
% difference	56	-

**T=MTW (Neo-treated) Tc=NMTW (control).*

DISCUSSION

Electrical conductivity (EC), viscosity and pH except total hardness of the magnetically treated water were higher than ordinary water. These results proved the beneficial effect of magnetic fields on the composition of irrigation water as reported by Grewal and Maheshwari (2011) that physical and chemical properties of magnetic water transformed such as hydrogen bonding, polarity, surface tension, conductivity, pH and soluble salts content. Magnetic treatment of irrigation water reduced surface tension, hardness and viscosity therefore supporting cowpea growth.

Treatments involved magnetized irrigation (MTW) had 51% germination percentages more than non-magnetized irrigation water (NMTW). These results supported the results obtained by Grewal and Maheshwari (2011) that a significant increase in snow peas with magnetic water and seeds compared to the control treatment due to the application of magnetic fields to both seeds and irrigation water. Magnetisation processes resulted to activation of enzymes and hormones of inactive embryo during germination process. Germination indices test indicated that MTW had highest germination percentage and lowest percentage was obtained for non-magnetic irrigation water.

Cowpea heights obtained from the study was in agreement with the results obtained by Abedinpour and Rohani (2015) where the application of magnetized water promoted maize seedling height and heavier than non-magnetized treatments. Hozayn and Abdul Qados (2010) results on chickpea showed that plants irrigated with magnetic water developed taller and heavier than control treatment using ordinary tap water. Magnetic field improved both the root and shoot systems in soybean and paulownia organ cultures (Aladjadjiyan, 2012). The cowpea stem diameters of magnetic treatments were better than non-magnetic treatments as shown in Table 4. El-Sayed and El-Sayed (2015) reported that broad bean plant irrigated with magnetized water improved significantly the plant height, fresh and dry weight of leaves, stem and root, leaf area as compared to the control treatment.

Statistical analysis using one sample t-test indicated that there was significant ($P<0.05$) difference at $P=0.0006$ and coefficient of determination R^2 value of 0.9599 on cowpea yield under magnetic and non-magnetic treatments. This result was in agreement with the studies of De Souza *et al.*, (2006) and Hozayn and Abdul Qados (2010) that broad bean plants irrigated with magnetic water improved the yield production significantly compared to normal tap water.

CONCLUSION

Treatment of irrigation water could be adopted as a new technology to improve cowpea production without any health hazards to the environment compared to application of inorganic fertilizers. Magnetic fields softened the water and improve its absorption through plant roots that sustained cowpea growth. Cowpea germination, growth and yield were improved through an application of magnetic irrigation water. MTW resulted in a significant ($P<0.05$) increase in germination index than the control treatment. Conclusively, magnetic agriculture is a promising technique that sustained cowpea production and environment.

RECOMMENDATION

Magnetized irrigation water was recommended as a better substitute for inorganic fertilizers that are hazardous to environment and increased production cost.

REFERENCES

Abedinpour, M. and Rohani, E. (2017). Effect of magnetized water application on soil and maize growth indices under different amounts of salt in the water. Journal of Water Reuse and Desalinisation 319-325.

Agyeman, K.,Berchie, J.N., Osei-Bonsu,I., Tetteh Nartey,E., and Fordjjour, J.K. (2014). Growth and yield performance of improved cowpea (*Vigna unguiculata L.*) varieties in Ghana. *Agriculture Science,* 2, 4:44-52.

Aladjadjiyan, A.2012. Study of the Influence of Magnetic Field on some Biological Characteristics of *Zea mays.* J. Cent. Eur. Agric. 3:89-94.

Davis, D.W., Oelke, E.A., Oplinger, E.S., Doll, J.D., Hanson, C.V. and Putnam, D.H. (1991). "Cowpea". Alternative Field Crops Manual. Last updated: 03 May, 2017.

De Souza A., Garcia D., Sueiro L., Licea L. and Porras E. 2005. Pre-sowing Magnetic Treatment of Tomato Seeds: Effects on the Growth and Yield of Plants Cultivated Late in the Season, Spanish Journal of Agricultural Research, 3(1):113-122.

Elfadil, A.G. and Abdallah, R.A. (2013). Effect of light, ultra violet and magnetized water on the growth and development of Dura (*Sorghum sp.*). Agriculture and Biology Journal of North America. 4(2): 91-96.

El-Sayed, H. and El-Sayed, A.2015. Impact of magnetic water irrigation for improves the growth, chemical composition and yield production of broad bean (*Vicia faba L.*) plant. *Journal of Nature and Science* 13(1):107-119.

Grewal, S.H. and Maheshwari, B.L. (2011). Magnetic treatment of irrigation water and snow pea and chickpea seeds enhances early growth and nutrient contents of seedlings. Bioelecromagnetics; 32(1):58-65.

Hozayn, M. and Abdul-Qados, A.M.S. (2010). Irrigation with magnetzed water enhances growth, chemical constituents and yield of chickpea (*Cicer arientinum L.)*. Agriculture and Biology Journal of North America 1(4): 671-676.

Huang, X.X and Bie, Z.L.(2010). Cinnamic acid-inbited ribulose-1, 5- bisphosphate carboxylase activity is mediated through decreased Spermine and changes in the ratio pf polyamines in cowpea. J. Plant Physiol. 167:47-53.

Ortiz, R. 1998. “Cowpeas from Nigeria: a silent food revolution”. Outlook on Agriculture. 27(2):125-128.

Reina, F.G., Pascual, L. A. and Fundora, I.A. 2001. Influence of a stationary magnetic field on water relations in lettuce seeds. Part II: Experimental results. Bioelectromagnetics, 22:596-602.

Shoeb, F., Yadav, J.S, Bajaj, S. and Rajam, M.V. (2001). Polyamines as biomarkers for plant regeneration capacity: improvement of regeneration by modulation of polyamines metabolism in different genotypes of Indian rice. *Plant Science*. 160:1229-1235.

Yusuf, K.O, Ogunlela, A.O.2015. Impact of magnetic treatment of irrigation water on the growth and yield of tomato. Notulae Scientia Biolgicae 7(3):345-348.

Zhang, W., Jiang, B., LI , W., Song, H., Yu, Y. and Chen, J. 2009. Polyamines enhance chilling tolerance of cucumber (*Cucumissativus L*.) through modulating antioxidative system. *Sciential Horticult* 120: 200-208.