Effect of Magnetized Water on Seed Germination, Growth and yield of Rocket Plant (Eruca sativa Mill).

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Abstract

A pot experiment was conducted at Faculty of Education, Alzaiem Alazhari University, Khartoum, Sudan to evaluate the effect of magnetized water and magnetized seeds on the rocket plant (Eruca sativa L.). The results showed a significant difference in germination, shoot length, leaf area, shoot and root fresh and dry weight, chlorophyll content, and some chemical elements (Ca, Mg, K, P, Fe). The results indicated some differences in soil characterization after rocket plant harvest.

Keywords: *Magnetized water, germination, soil elements, yield component*

I. INTRODUCTION

Over many years, the effects of static magnetic fields on plant have been the subject of different research studies. Exposure of seed to electromagnetic fields is one of the safe and affordable potential physical pre-sowing treatments to enhance post germination; plant development and crop stand [12]. Magnetic fields affected the various characteristic of the plant like germination of seeds, root growth, rate of seedling growth, reproduction and growth of meristem cells and chlorophyll quantities [24],[28].

The technology of magnetic water has widely studied and adopted in the field of agriculture in many countries, however, in Sudan the available studies and application of magnetic water in agriculture is very limited. Therefore the present work aimed to study the effect of pre-sowing treatment of water and seeds of rocket plant on the germination, growth, yield and some of the chemical constituents of rocket plant.

II. MATERIALS AND METHODS

Dry rocket plant (*Eruca sativa* Mill) seeds were passed through the magnetic funnel slowly with uniform speed, hen seeds were used immediately after passing through the magnetic funnel.

The seeds of rocket plant were exposed to six treatments as shown below:

1. Treatment one, normal seeds irrigated with tap water as a control (T_1).
2. Treatment two, normal seeds irrigated with magnetized water (T_2).
3. Treatment three, normal seeds irrigated with magnetized water twice (T_3).
4. Treatment four, magnetized seeds irrigated with tap water (T_4).
5. Treatment five, magnetized seeds irrigated with magnetized water (T_5).
6. Treatment six, magnetized seeds irrigated with magnetized water two times (T_6).

The water used for irrigation in this experiment was passed through the magnetic funnel and then used for irrigation to the treated and untreated seeds.

Seed germination:

Plastic pots (35cm in diameter and 35cm in depth) were arranged in a completely randomized design. Each pot contained a mixture of clay and sand, soil (2:1). There were three replications for each treatment. Seeds were sown in a uniform depth 20mm and five seeds per pot. Measured volume (600ml/pot) of water with or without magnetic treatment was applied in each pot soon after sowing according to the treatments described earlier and then daily during the entire duration of the experiment. The number of seedlings emerged were counted daily for each treatment. At harvest, seedlings shoots were separated from roots, weighted for fresh weight and then dried in an oven at 65.8^{o}C for 48h for the dry weight. The dried seedlings were than analyzed for nutrient concentration. Part of the dried shoot of rocket plant were digest in nitric acid, and used for determination of P, K, Ca, mg, Mn, Fe and Zn concentrating. Chlorophyll a, chlorophyll b, total chlorophyll (a+b) and carotene were estimated according to [4].

III. RESULTS AND DISCUSSION

Table (1) showed the germination percentage of rocket plant with highest germination percentage of (93.3%) at treatment T_5 and the lowest value (76.7%) at the control.

The results of this study are supported by the findings of [15] who reported that improvement in germination and seedling emergence of tomatoes, pepper, cucumber and wheat when magnetically treated water and seeds were used, and the results of [22] who observed an increase in germination of *Pinus tropicalis* seeds with magnetically treated water. The irrigation with magnetically treated water and seed absorption of magnetized water before sowing may be responsible for activation of enzymes

and hormones involved in the germination process and mobilization of nutrients. As a result, there is probably an enhancement in the mobilization and transportation of nutrient to embryonic axis and a resultant increase in speed of emergence and germination rate. Table (2) indicated that plant height of rocket plant was significantly increased except treatment T_2, which was non-significant. In this respect [6] concluded that magnetic field increased the shoot and root regeneration rate in soybean. [1] reported that irrigation flax with magnetized water increased plant height, also [19] reported that an increase in plant height, seedling weight of maize were noted with magnetized water. These results may be attributed to the role of magnetic treatment in increasing absorption and assimilation of nutrients consequently increasing plant growth.

Table (I): **Effectof Magnetized Water and Seeds on the Germination of Rocket Plant (*Eruca sativa*) at Field Experiment.**

Treatment	Germination percentage Days after sowing	
	1	2
T_1	76.7	80.08
T_2	91.7	95.0
T_3	790	90.0
T_4	91.9	100.0
T_5	93.3	100.0
T_6	86.7	100.0
LSD	1.05	2.66

Table (II): **Effect of Magnetized Water and Seeds on the Growth Parameters of Rocket Plant (*Eruca sativa*).**

Treatment	Shoot length (cm)	Number of leaves	Leaf area (cm^2)
T_1	7.6	4.33	10.47
T_2	8.60	5.00	19.83
T_3	10.80	4.80	25.57
T_4	14.20	6.67	45.83
T_5	12.30	5.33	35.83
T_6	15.50	7.00	45.77
LSD	2.33	1.53	18.57

The number of leaves showed a significant difference between treatments except treatment T_3 was not significant. The leaf area expressed a significant difference (P=0.05) between treatments. These results concur with that of [25] who found an increment in leaf area of okra treated with magnetic field compared to control, and the results of [10] who found an increase in leaves area and plant height of beans and peas when irrigated with magnetic water. The increment in leaf area might be due to increased photosynthetic rates due to greater interception of light [27], [30].

The shoot fresh and dry weight (Table 3) showed a significant difference between treatments and these results are supported by the findings of [11] who reported that sunflower seedling exposed to vertical magnetic fields showed a small but significant increase in total fresh weight, shoot fresh weight and root fresh weight. The rootlength showed a non significant increase where rocket plant irrigated with magnetized water and seeds. Table (3) indicated a significant increase in root fresh and dry weight except treatment T_3 in dry weight showed a non-significant difference**.**

Reference [14] reported that an increase in root dry weight of chick pea and snow pea irrigated with magnetic water and the results of [17] who reported that an increase in root weight in sugar beet irrigated with magnetized water compared with non magnetized water.

Photosynthetic pigments (chlorophyll a, chlorophyll b and carotenoids) in rocket plant exhibited remarkable increase in response to the irrigation with magnetized water and seeds when compared to tap water plants as shown in Table (3). These results are in good agreement with that of [6], [9], [20]. They showed that the increase in chlorophyll and carotenoid content specifically appeared after treatment with magnetic water. Also [16] concluded that significant increases in pigment fraction were recorded in chick pea plants irrigated with magnetized water compared to control treatment. In connection to this, [29], [5] found an increase in chlorophyll content specifically

Table (III): **Effect of Magnetized Water and Seeds on the Yield, Chlorophyll Content and Water Productivity of Rocket Plant (*Eruca sativa*).**

Parameter measured	Treatments						LSD
	T_1	T_2	T_3	T_4	T_5	T_6	
Shoot fresh weight (g)	4.32	4.58	4.88	2.88	3.51	5.43	0.001
Shoot dry weight (g)	0.25	0.30	0.29	0.18	0.15	0.23	0.000
Root length (cm)	5.90	5.96	6.30	5.98	5.16	5.99	0.015
Root fresh weight (g)	0.04	0.07	0.07	0.11	0.08	0.11	0.000
Root dry weight (g)	0.01	0.02	0.01	0.03	0.02	0.02	0.000
Chlorophyll (a) %	2.02	1.70	2.96	2.48	2.98	2.55	0.010
Chlorophyll (b)	1.56	1.59	1.69	0.52	1.86	1.26	0.001
Carotenoids %	5.51	3.46	3.60	3.40	3.74	3.69	0.012
Water productivity	0.007	0.0013	0.0020	0.0035	0.0035	0.0057	0.000

appeared after exposure to a magnetic field for a short time. Also the work of [2] who observed that sweet pepper (Capsicum annuum L.) leafcontents of chlorophyll a and chlorophyll b, carotenoids and phosphorus were significantly affected y the magnetic field.

The chemical analysis of rocket plant showed an increase in some element contents (Table 4). The highest value of calcium concentration (8.053%) was measured at treatment T_6 and the lowest value (5320%) at the control. Plant processes such as growth, photosynthesis, mineral nutrition, water transport are quite related to the motion of Ca^{++} ion in cells, changes in intercellular levels of Ca^{++} and other ionic current density across cellular membrane are important changes which are due to magnetic fields [12]. Concerning magnesium, the highest value (17.34%) was observed at treatment T_4 and the lowest value (15.73%) was found at the control. Magnesium ions are found in the centre of chlorophyll molecules, and as chlorophyll is an essential component in the reaction of photo-synthesis, which produces energy for growth, magnesium ions are therefore essential [8]. Table (4) indicated an increase in potassium content with the highest value (627.0%) at treatment T_4 and the lowest value (45.30%) at the control. These results are in agreement with the results of [31] who reported that the content of some elements in buck wheat straw (P, Ca, K, Zn) was greater in seeds exposed to magnetic field and the results of[23] who demonstrated that, there is a direct effect of potassium upon translocation efficiency, because potassium ion is known to be one of the three largest constituents in sieve tube sap. Concerning phosphorus the highest value (3.95%) was observed at treatment T_5, while the lowest value (3.00%) was found at the control. These results agreed with the results obtained by [3] who observed an increase in phosphorus content in jojoba (*Simmondsia cinesis* L.) treated with magnetic water and [7] found a significant increase in phosphorus percentage in cotton treated with magnetized water compared to the untreated plants. In regard to iron content in rocket plant Table (4) showed significant difference between treatments with highest value (214.29%) achieved by treatment T_6, while the lowest value (13.0%) was found at the control. Similar results were reported by [31], where an increase in iron content in buck wheat straw was observed when the seeds were magnetically treated.

Table (IV): **Effect of Magnetized Water and Seeds on Some Elements Concentration of Rocket Plant (*Eruca sativa*).**

Treatments	Element concentration (ppm)				
	Ca	Mg	K	P	Fe
T_1	5.320	15.73	45.0	3.00	13.00
T_2	6.242	16.34	553.00	3.87	90.06
T_3	7.757	16.27	611.00	3.87	56.43
T_4	7.654	17.34	627.00	3.60	36.45
T_5	6.548	16.53	543.00	3.95	58.49
T_6	8.053	16.43	561.00	3.17	214.29
LSD	0.000	0.29	13.61	0.59	7.10

Table (V): **Effect of magnetized water and seeds on characterization of the soil samples after plant harvest.**

treatment	ECe	pH	Ca^{2+} (mq/L)	Mg (mq/L)	Na^{2+} (mq/L)	K^{2+} (mq/L)	P (ppm)	Cl (mq/L)
T_1	1.369	6.19	4.8	2.2	2.57	`0.17	0.56	2.75
T_2	0.789	.30	4.9	3.3	4.04	0.19	0.84	4.50
T_3	0.910	6.45	4.9	3.4	5.00	0.18	063	3.25
T_4	0.945	6.39	5.9	3.4	4.17	0.19	0.61	3.02
T_5	0.635	6.43	5.2	2.8	4.39	0.18	0.57	3.25
T_6	1.146	6.30	7.2	5.9	5.13	0.15	0.67	3.53

Table (5) above showed some chemical analysis of soil used after harvest. The magnetized water had a slight effect in decreasing EC values after the harvest of rocket plant. Slight increase in pH of soil irrigated with magnetically treated water compared to control. The soluble soil Ca2+, Mg2+, K and P were increased when used magnetized water, while the soil soluble Na+ was decreased when using magnetized water. Similar results were obtained by [21], they found an increase in soluble soil K, Mg2+ and Ca2+ when using magnetized water. Also [26] observed differences in the concentrations of N, P, K in soils irrigated with magnetically treated water when compared those with normal water. In addition [18] found that an increase in soil available P and K, particularly under magnetically treated recycled water and saline water irrigation.

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