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Effect of Magnetized Water and Seeds on the Growth and Yield of Sesame (*Sesamum indicum* L.) under Irrigation

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Abstract: Magnetic treatment is hypothesized to result in the improvement of the performance of some crops. A field study was conducted to evaluate the effect of magnetized water and seeds on growth and yield of sesame (cv. Promo). An experiment was carried out for two consecutive seasons (2004/05 and 2005/06) in the Demonstration Farm, Faculty of Agriculture, Shambat, Sudan. The seeds were either sown directly or after passing them through a magnetic field. The crop received equal quantities of either normal or magnetized water every 14 days. The results showed that magnetized water and seeds consistently had non-significant positive effect on mean plant height, number of leaves per plant and stem diameter. The plants irrigated with magnetized water took significantly fewer days to flower than their respective untreated plants. Magnetized water and seeds significantly increased seed yield due to increased number of capsules per plant. In contrast, all treatments had no significant effect on mean 1000-seed weight and oil content of seeds.

Key words: Sesame; magnetic field; irrigation; Sudan

INTRODUCTION

In Sudan, sesame (*Sesamum indicum* L.) is an important crop both for local consumption and export. It is normally grown in the rain-fed sector under both mechanized and traditional farming systems. The cultivated area and yield fluctuated from year to year due to variation in the production factors (Khidir 2007).

Recent research indicated that magnetic water improves the performance of some crops, e.g. sorghum, maize and groundnut, grown under irrigation (Tkatchenko 1997). In this respect, magnetization of irrigation

water increased the germination rate and yield of these plants (Yasin 1995; Mustafa 1998). Moreover, treatment of cotton plants with magnetic water resulted in yield of about 3200 kg/ha compared with 2000 kg/ha for the control (Makhmoudor 1998). Other studies showed that seeds treated with magnetic field may improve the germination and yield of some crops (Mustafa 1998; El Hassan 2004). Most of these results were attributed to the effect of the magnetic treatments on some water properties (Higashitani and Oshitani 1997; Parsons *et al*. 1997). However, most laboratory and field studies have reported mixed results as to the overall usefulness of the technology. Therefore, the objective of this study was to investigate the effect of magnetized water and seeds on growth and yield of sesame under irrigation.

MATERIALS AND METHODS

A field experiment was conducted during two consecutive seasons (2004/05 and 2005/06) in the Demonstration Farm of the Faculty of Agriculture at Shambat**,** University of Khartoum (Latitude 15°40′N, Longitude 32°32′E and Altitude 386 m *asl*). The soil of the experimental site is clayey (fine Montomorilanitic, Isohyperthermic Entichromusturt) with alkaline pH.

The experiment was designed to study the effect of water and seeds treated with magnetic field on growth and yield of sesame (cv. Promo). The crop received equal quantities of either normal water (W_0) or magnetized water (W_1) every 14 days. The seeds were either sown directly (S_0) or after passing through a magnetic field (S_1). Magnetic treatment of water and seeds was done by passing them through two pools of magnetic field using Magnetron device and magnetic funnel, respectively (Magnetology LLC, United Emirates). The experimental treatments were arranged in 2 x 2 split-plot design with four replications in the two seasons. The main plots were allotted for the watering treatments and the subplots for the seed treatments.

The land was ploughed, harrowed, leveled and ridged 70 cm apart. The plot size was 4×5 metres consisting of five ridges of 5 metres in length. In each plot, the three inner ridges were used for sampling and the two outer

ridges were left as guard area. Sowing was done manually in lines on the side of the ridge. The plants were later thinned to 50 per ridge at 10 cm between plants (125 x 10^3 plants/ha). The sowing date was in the second week of June in both seasons. Weeding was done twice during the growing season.

Four plants were randomly chosen and tagged in each subplot, and data were collected on plant height, number of leaves/plant**,** stem diameter, height to the first flowering node, height to the first capsule, number of days to the first flower, number of days to 50% flowering, number of capsules/plant, 1000-seeds weight, and seed yield (kg/ha). Using a Soxhlet apparatus, the oil content (%) of the seeds was determined according to AOAC (1984). Data were subjected to the analysis of variance, according to Gomez and Gomez (1984). Least significant difference (LSD) test was used to separate the means of the different characters.

RESULTS

Statistical analysis showed that magnetized water, seeds and their interactions had no significant effect on mean plant height, number of leaves per plant and stem diameter at all sampling occasions and in both seasons. However, magnetized water (Fig. 1) and seeds (Fig. 2) increased the mean values of these characters relative to non-magnetized treatments, in both seasons.

In both seasons, magnetized treatments increased the height to first flowering node and height to first capsule, but the increase was not significant (Table 1). Plants irrigated with magnetized water took fewer days to start flowering, in both seasons, compared with the control (Table 1). In the second season, the number of days to 50% flowering was less in plants grown from seeds treated with a magnetic field (Table 1).

Statistical analysis revealed that magnetized water (W_1) and seeds had significant effect on seed yield of sesame, in both seasons. W_1 increased the mean seed yield relative to the control (W_0) by 34% and 28% in the first and second seasons, respectively (Table 2). The relative increases in

sesame yield, as a result of seed treatment with a magnetic field, were 32% and 10% in the first and second seasons, respectively (Table 2). Plants irrigated with magnetized water or grown from magnetized seeds produced significantly more capsules than untreated plants (Table 2). In contrast, analysis of variance revealed that all treatments had no significant effect ($P \geq 0.05$) on mean 1000-seed weight and seed oil content in both seasons (Table 2).

DISCUSSION

Some researchers (e.g. Joshi and Kamat 1966; Busch *et al*. 1986; Ibrahim 2006) hypothesized that magnetic treatment of water affects the nature of the hydrogen bonds between water molecules resulting in changes in some water properties such as light absorbance, surface tension and pH. Therefore, the positive effect, though insignificant, of the magnetic water treatments observed in this study may be attributed to these properties which are expected to improve the absorption of dissolved mineral nutrients by the plants as reported by many investigators (e.g. Tkatchenko 1997; Mustafa 1998; Chang and Weng 2008).

The increase in plant height under the magnetic treatments may be attributed to the increase in the length of internodes and number of nodes per plants (data not shown). Similar observations were reported in sorghum treated with magnetized water (Badr Eldein Hasab Elrasoul, personal communication). Magnetization treatment also increased the number of leaves per plant and stem diameter. This improvement in plant growth parameters may be attributed to the high solubility and ready absorption of nutrients under magnetic treatments as reported by Tkatchenko (1997) and Mustafa (1998).

The increase in height to the first flowering node and first capsule may be due to the greater stem length and number of nodes per plant under the magnetic treatments. Similarly, magnetic treatment of seeds hastened flowering by shortening the vegetative period. Supporting evidence was reported by Saeed (2006) who found similar results in cucumber plants.

The greater number of capsules per plant was obtained under magnetized water and seed treatments. This may be attributed to the longer main stem and greater number of branches per plant observed under these treatments. Seed yield was significantly affected by magnetized water and seeds as previously indicated by Saeed (2006). The improvement in this character may be attributed to the greater number of capsules under these treatments. Similar results were reported by Osman and Khidir (1974) who showed that sesame seed yield is positively correlated with the number of capsules per plant.

The non-significant effect of the treatments on most of the parameters measured in this study may be attributed to the intensity and duration of exposure to the magnetic field. This suggestion supports the results of Nelson (2000). He showed that increasing the exposure of seeds to magnetic field increases the percentage of germination in apple seeds, increases the snap bean yield, the growth of legumes and cereals, and the rate of tomato ripening. On the other hand, Nelson (2000) reported that a low magnets intensity field may affect some biological processes as much as high intensity magnets. He also found that a field strength of low intensity increase the growth rate of beans, cucumber, lupines and maize but rye was unaffected by high intensity field, and the greatest results were obtained at temperatures which are optimal for the growth of each type of plant. These contradicting results suggest that any future research should consider all these aspects of magnetic field treatments.

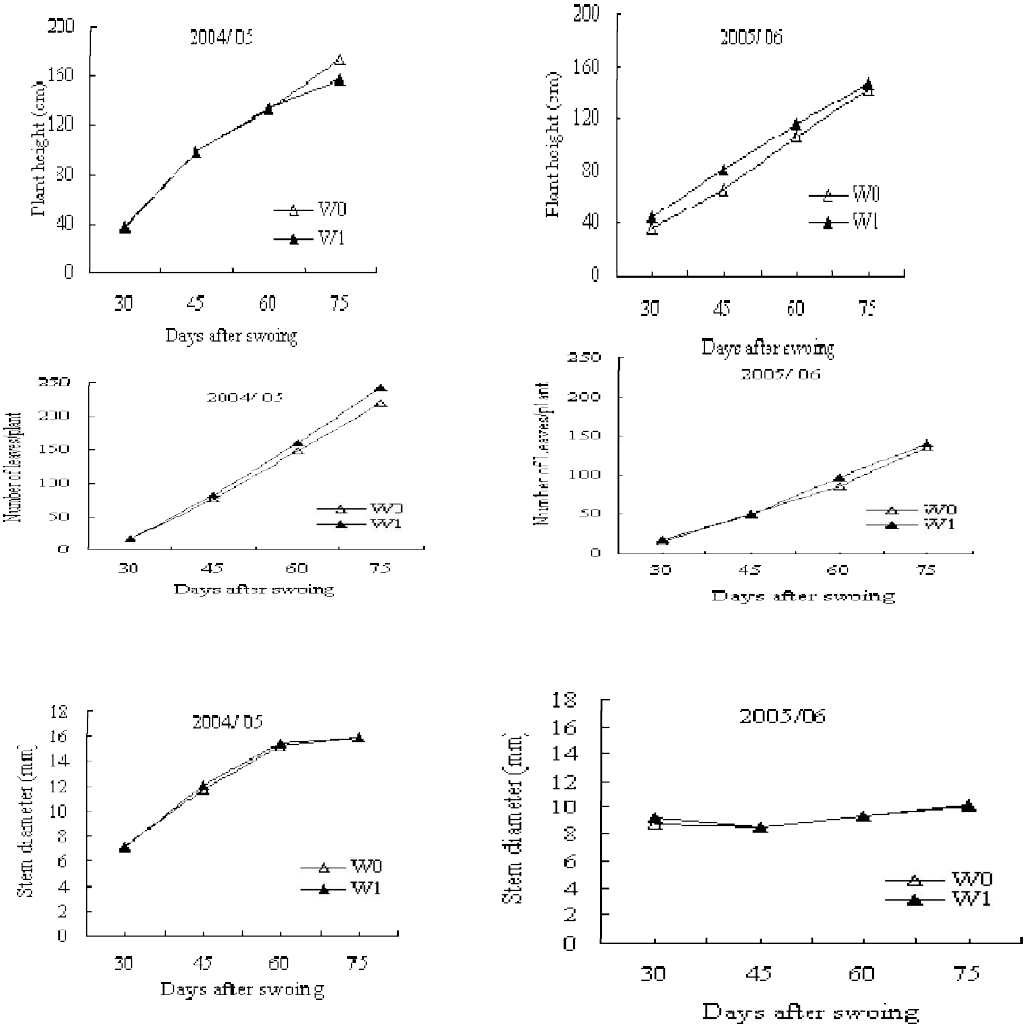

Fig. 1 Effect of magnetized water on plant height, number of leaves per plant and stem diameter of sesame grown during 2004/05 and 2005/06 seasons

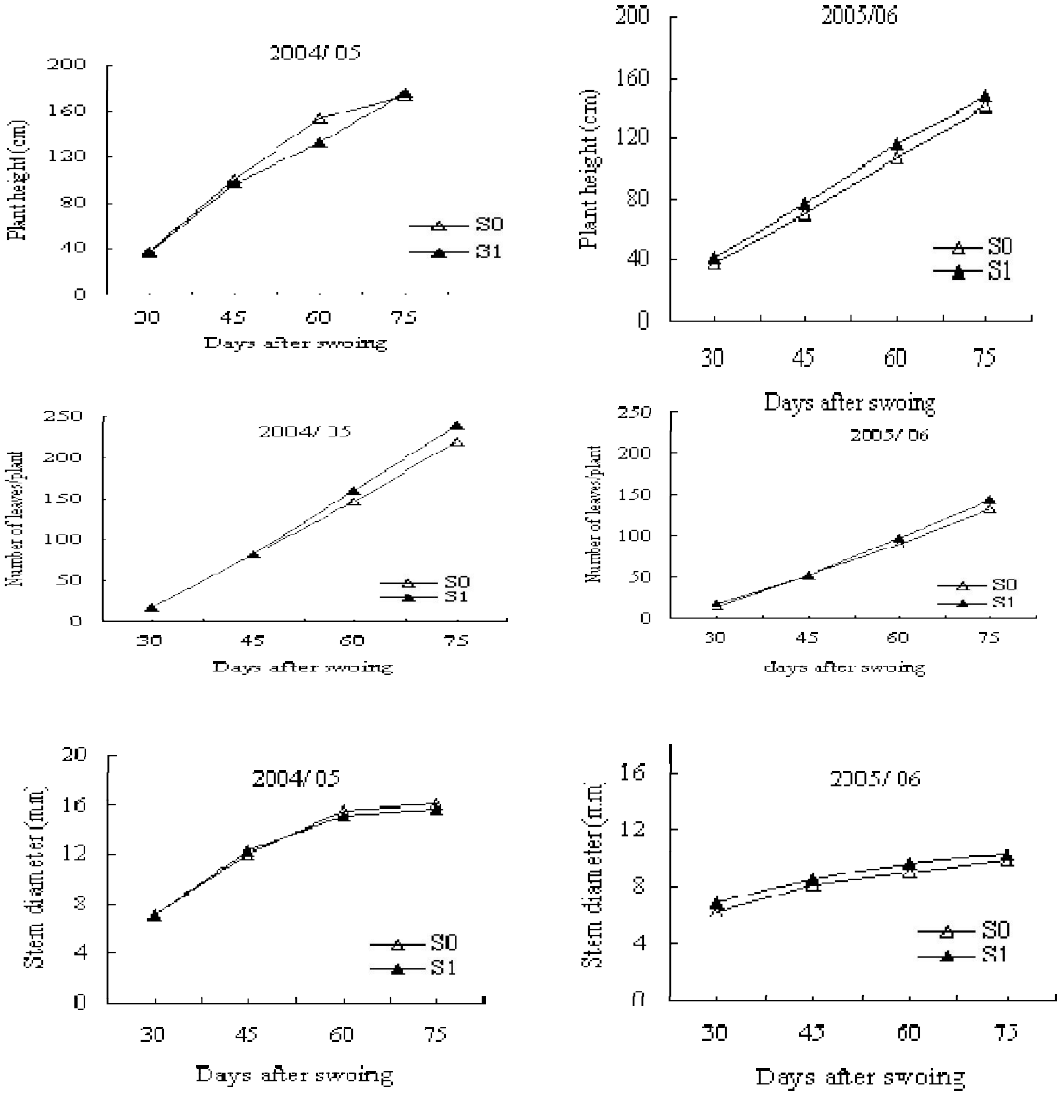

Fig. 2 Effect of magnetized seeds on plant height, number of leaves per plant and stem diameter of sesame grown during 2004/05 and 2005/06 seasons

Table 1. Effect of magnetized water and seeds on some phonological characters of sesame grown during 2004/05 and 2005/06 seasons

Treatment	Height to 1st flower (cm)			Height to 1st capsule (cm)			Days to first Flower			Days to 50% flowering		
	S_0	S_1	Mean	S_0	S_1	Mean	S_0	S_1	Mean	S_0	S_1	Mean
2004/05												
W_0	117.8	121.7	119.8	124.8	124.6	124.7	49.5	49.4	49.5	59.7	55.7	57.7
W_1	120.4	125.8	123.1	123.7	129.0	126.4	47.6	47.4	47.5	56.0	53.1	54.6
Mean	119.1	123.8		124.3	126.8		48.6	48.4		57.9	54.4	
$LSD_{0.05}$ for		9.6			7.5			1.3			2.1	
W		6.6			5.7			3.1			1.8	
$LSD_{0.05}$ for		9.3						7.5			2.5	

S

$LSD_{0.05}$ for W×S

Table 1. Cont.

Treatment	Height to 1st flower (cm)			Height to 1st capsule (cm)			Days to first flower			Days to 50% Flowering		
	S_0	S_1	Mean	S_0	S_1	Mean	S_0	S_1	Mean	S_0	S_1	Mean
					2004/05							
W_0	82.2	89.9	86.1	96.3	105.5	100.9	47.6	43.9	45.8	61.7	58.1	59.9
W_1	86.2	95.0	90.6	106.4	108.5	107.5	42.9	44.3	43.6	59.3	54.9	571
Mean	84.1	93.0		101.4	107.0		45.3	44.1		60.5	56.5	
$LSD_{0.05}$ for		10.4			13.5			1.5			1.9	
W		9.6			8.0			3.1			5.6	
$LSD_{0.05}$ for		13.6			11.4			4.4			7.2	
S												
$LSD_{0.05}$ for W×S												

W_0 = Normal water; W_1 = Magnetized water; S_0 = Untreated seeds; S_1= Magnetized seeds

Table 2. Effect of magnetized water and seeds on yield and yield components of sesame grown during 2004/05 and 2005/06 seasons

Treatment	Capsules/plant (No.)			1000-seed weight (g)			Seed yield (kg/ha)			Oil content (%)		
	S_0	S_1	Mean	S_0	S_1	Mean	S_0	S_1	Mean	S_0	S_1	Mean
2004/05												
W_0	75.0	90.9	83.0	3.7	3.6	3.7	400.3	502.4	451.4	53.9	53.3	53.6
W_1	87.2	93.5	90.4	3.6	3.8	3.7	510.0	696.5	603.3	53.2	54.4	53.8
Mean	81.1	92.2		3.7	3.7		455.2	599.5		53.6	53.9	
$LSD_{0.05}$ for W		4.5			0.4			37.2			5.8	
$LSD_{0.05}$ for S		4.5			0.2			49.9			5.7	
$LSD_{0.05}$ for W×S		12.5			0.3			112.0			6.0	

Table 2. Con.

Treatment	Capsules/plant (No.)			1000-seed weight (g)			Seed yield (kg/ha)			Oil content (%)		
	S_0	S_1	Mean	S_0	S_1	Mean	S_0	S_1	Mean	S_0	S_1	Mean
2004/05												
W_0	78.8	84.0	81.4	3.6	3.8	3.7	414.5	528.6	471.6	53.6	54.0	53.8
W_1	84.2	88.5	86.4	3.8	3.5	3.7	608.8	601.4	605.1	53.5	54.5	54.0
Mean	81.5	86.3		3.7	3.7		511.7	565.0		53.6	54.3	
$LSD_{0.05}$ for W		3.1			0.3			25.1			4.2	
$LSD_{0.05}$ for S		4.0			0.2			45.0			6.0	
$LSD_{0.05}$ for W×S		17.0			0.3			91.6			9.0	

W_0 = Normal water; W_1 = Magnetized water; S_0 = Untreated seeds; S_1 = Magnetized seeds

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تأثير الماء الممغنط والبذور الممغنطة على نمو وإنتاجية السمسم المروي

فيصل القاسم احمد وزينب ابراهيم محمد

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المستخلص: هنالك إفتراض أن المعاملة بالمغنطة قد تؤدي إلى تحسن في أداء بعض المحاصيل. أُجريت دراسة حقلية لتقويم تأثير الماء الممغنط والبذور الممغنطة على نمو وإنتاجة السمسم (الصنف يرومو). نُفذت تجربة حقلية لموسميين متتاليين (2005/2004 و 2006/2005) بالمزرعة التجريبية لكلية الزراعة بشمبات. زُرعت البذور اما مباشرة أو بعد تعرضها لمجال مغناطيسي ورويت كل 14 يوم بكميات متساوية من الماء الممغنط او العادي. أظهرت النتائج ان للمعاملات آثاراً إيجابية، إلا أنها غير معنوية، على طول النبات، وعدد الاوراق في النبات، وقطر الساق. أُخذت النباتات المروية بالماء الممغنط زمناً اقصر معنوياً للإزهار مقارنة بالنباتات المروية بالماء العادي. أدى الماء الممغنط والبذور الممغنطة إلى زيادة معنوية في الإنتاجية نتيجة لزيادة عدد العليبات في النبات. على النقيض لم يكن لكل المعاملات تأثير معنوي على وزن ومحتوى البذور من الزيت.