International Journal of Biological, Life and Agricultural Sciences
ISSN: 2415-6612
Vol:4, No:8, 2010

Effect of Magnetic Field on Seed Germination of Two Wheat Cultivars

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***Abstract*—**The effect of magnetic field on germination characteristics of two wheat Seeds has been studied under laboratory conditions. Seeds were magnetically exposed to magnetic field strengths, 125 or 250mT for different periods of time. Mean germination time and the time required to obtain 10, 25, 50, 75 and 90%of seeds to germinate were calculated. The germination time for each treatment were in general, higher than corresponding control values, in the other word in treated seeds time required for mean seed germination time increased nearly 3 hours in compared non treated control seeds. T_{10} for doses D_5, D_6, D_{11} and D_{12} significantly higher than the control values for both cultivars. Mean germination time (MGT) in both cultivars significantly increased when the time of seed exposed at magnetic field treatments increased , about 3 and 2 hour respectively for Omid and BCR cultivars.

***Keywords*—**wheat, cultivar, germination test, magnetic field

I. INTRODUCTION

WHEAT (*Triticum aestivum* L.) is one of the world's most important food crops. Seed vigor is defined as the sum total of those properties of the seed which determine the level of activity and performance of the seed or seed lot during germination and seedling emergence [8]. High seed vigor, i.e. rapid, uniform, complete emergence of vigorous seedling, leads to high grain yield of wheat by shortening the days from sowing to complete ground cover, allows the establishment of optimum canopy structure that maximizes crop yield.

Biological stimulation plays an important role in optimizing crops in terms of the maximization of yield, promotion of plant growth, and protection against disease [18]. The main advantage of using electromagnetic stimulation methods over traditional chemical processes is the absence of toxic residues [18]. Savostin [17] observed increase in the rate of wheat seedling elongation under magnetic conditions. Then, Murphy [14] reported changes in seed germination due to a magnetic field. Exposure of seeds to magnetic field for a short time was found to help in accelerated sprouting and growth of the seedlings [19]. They reported the enhancement of plant growth under magnetic conditions.

Aladjadjiyan [2] detected that seed exposure to a 150 mT magnetic field stimulated shoot development and led to increase of the germination, fresh weight and shoot length of maize plants. Studies indicated that suitable magnetic treatment increased the absorption and assimilation of nutrients, and ameliorated photosynthetic activities [10].

Physiological mechanisms of magnetic field on germination and seedling growth are not completely understood. Magnetic field treatment of seeds leads to acceleration of plants growth, proteins biosynthesis and root development [11]. Akoyunoglou [1] and Racuciu and et al. [16] reported that the activities of some enzymes were increased by exposure to magnetic field. Changes in amylase and nitrate reductase activities in germinating seeds treated by electromagnets of different field strengths were also observed [4].

The main objective of this work is to quantify the possible effects of magnetic treatment on the germination characteristics and heterotrophic growth of wheat seeds subjected to a stationary magnetic field.

II. MATERIAL AND METHODS

A. Seeds and magnetic treatment

Germination tests were carried out at laboratory conditions with two cultivars wheat seeds named *Omid* and *Backcross Roshan* (BCR*)*. This experiment was conducted as completely randomized design with four replications. Each plot contained 25 seeds of each cultivar. Germination tests were performed according to the guidelines issued by the International Seed Testing Association [9]. Each filter paper with seeds was rolled and placed in a vessel containing distilled water. Four hours later, when seeds were soaked, each roll was subjected to a magnetic treatment.

The procedure of study was conducted according to Florez et al. [6], briefly magnetic treatment was provided as doses (D), varying the exposure time t and the magnetic field induction (B). the magnetic fields generated by ring magnets with magnetic induction values B_1 =125mT and B_2 = 250mT; the geometric characteristics are 7.5cm external diameter, 3cm internal diameter, 1cm high for B_1 and 1.5cm high for B_2. The magnet was placed at the top of the vessel to generate each magnetic dose, and each roll containing 25 seeds was placed into hole of the magnet for the time established for each dose.

The doses D_1-D_{12} applied were obtained by exposing the seeds to each magnetic field induction for different time, as fallows: 1-Exposure to 125 mT: D_1 (10min), D_2 (20min), D_3 (30min), D_4 (1h), D_5 (24h), D_6 (continuous exposure). 2-Exposure to 250 mT: D_7 (10min), D_8 (20min), D_9 (30min), D_{10} (1h), D_{11} (24h), D_{12} (continuous exposure).Four rolls carrying 25 seeds were used for each magnetic dose and an additional four rolls for control seeds (non exposed seeds). All the vessels containing rolls with seeds were labeled with

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numbers and randomly located to carry out the test. The distance between any two vessels was at least 25 cm, to avoid the influence of each magnet on the other vessels around. Label numbers were not related to the magnetic dose applied, so that scores of germinated seeds and other measurements were blind [6].

B. Germination test

The artificial light cycle was 12-h light/12-h darkness and the daily temperature 20±2 ^{0}C, night temperature 18±2 ^{0}C. The number of germinated seeds was recorded 4 times per day for the time necessary to achieve the final number or percentage of germinated seeds (G_{max}). Seeds were observed daily for up to 7 days and considered germinated when the radicle was approximately 2 mm long or more. The rate of germination was assessed by determining the mean germinating time (MGT) and time required to germinate 10, 25, 50, 75 and 90% of seeds (parameters T_{10}, T_{25}, T_{50}, T_{75} and T_{90}).

C. Statistical analyses

The results were subjected to an analysis of variance (ANOVA) to detect differences between mean parameters. Means were compared using with Duncan test to detect differences between parameters of treated plants and control.

III. RESULTS AND DISCUSSION

Seed germination

The percentage of germinated seeds (G_{max}), time required for germination (parameters MGT, T_{10}-T_{90}) were determined for each treatment are presented in tables 1 and 2.

The germination time for each treatment were in general, higher than corresponding control values, in the other word in treated seeds time required for mean seed germination time increased nearly 3 hours in compared non treated control seeds. Thus the rate of germination of treated seeds was lower than the untreated seeds. The time needed to germinate 10%, of the seeds exposed to 125 mT for 10(D1), 20(D2), 30(D3) and 60(D4) minute and exposed to 250 mT for 10(D7), 20(D8), 30(D9) and 60(D10) minute were statistically similar to control (tables 1, 2). Results showed that time required for T_{10} for doses D_5, D_6, D_{11} and D_{12} were 23.25, 27, 35.25 and 31.50 respectively that significantly higher than the control values for Omid cultivar(table 1). Similar results obtained for BRC cultivar (table 2). As T_{10} in closely related to the onset of germination, these results indicate no response (for 8 treatments) and the delay of germination (for 4 treatments) of wheat seeds to magnetic field. Mean germination time (MGT) in both cultivars significantly increased when the time of seed exposed at magnetic field treatments increased , about 3 and 2 hour respectively for Omid and BCR cultivars.

Data measured on 7 days after seedlings allow us to corroborate the effect observed in the germination test. seeds final germination significantly affected by treatments (tables 1, 2).in Omid cultivar exposure of seed at magnetic field with D3, D6, D10, D11 and D12 caused seed germination significantly reduced but germination at D2 and D4 significantly increased. This reduction happened for BCR cultivar only at D12 .D5, D9 and D11 significantly increased seed germination. The stimulatory effect of the application of different magnetic doses on the germination is in agreement with that obtained by other researchers. Florez et al. [6] observed an increase for initial growth stages and an early sprouting of rice and maize seeds exposed to 125 and 250 mT stationary magnetic fields. Martinez et al. [12, 13] observed similar effects on wheat and barley seeds magnetically treated. Alexander and Doijode [3] reported that pregermination treatment improved the germination and seedling. Vigor of low viability rice and onion seeds. Kavi [10] found that seeds exposed to a magnetic field absorbed more moisture. Carbonell et al. [5] found that magnetic treatment produced a biostimulation of the germination.

The mechanisms at work when plant and other living systems are exposed to a magnetic field are not well known yet, but several theories have been proposed, including biochemical changes or altered enzyme activities by Phirke et al. [15]. Garcia and Arza [7] carried out an experimental study on water absorption by lettuce seeds previously treated in a stationary magnetic field of 1-10 mT; they reported an increase in water uptake rate due to the applied magnetic field, which may be the explanation for increase in the germination speed of treated.

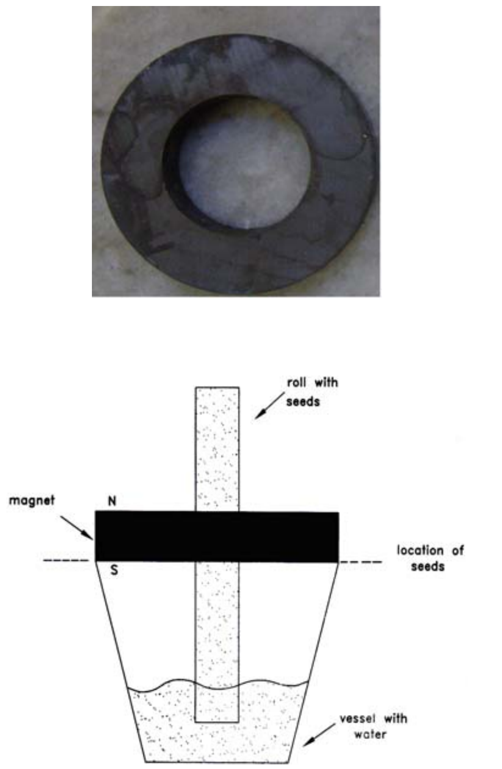

Fig.1. (a) Magnet and (b) vessel containing distilled water. Roll of filter paper with seeds and the hollow cylindrical magnet. N, S: North and South poles of magnet (fig. from Florez et al., [6]).

TABLE I .EFFECT OF MAGNETIC FILED ON GERMINATION OF WHEAT SEEDS (OMID CULTIVAR)

Dose	T_{10} (h)	T_{25} (h)	T_{50} (h)	T_{75} (h)	T_{90} (h)	MGT (h)	G_{max} (%)
B=125mT							
D_1	13.50^{d}	17.25^{c}	21.00^{d}	25.5^{d}	33.00^{bc}	22.05^{c}	96.25^{b}
D_2	15.75^{c}	19.50^{bc}	24.00^{c}	30.75^{c}	36.00^{b}	25.20^{bc}	97.50^{a}
D_3	15.00^{c}	18.00^{bc}	27.75^{c}	35.25^{b}	39.00^{a}	27.00^{b}	91.25^{c}
D_4	17.25^{c}	20.25^{b}	25.50^{c}	31.5^{c}	34.50^{b}	25.80^{bc}	98.75^{a}
D_5	23.25^{b}	29.25^{a}	33.00^{b}	36.75^{b}	40.50^{a}	32.55^{a}	96.25^{b}
D_6	27.00^{a}	31.50^{a}	36.00^{a}	40.5^{a}	-	27.00^{b}	81.25^{c}
Mean	18.63	22.63	27.88	33.38	36.6	26.6	
B=250mT							
D_7	12.00^{d}	15.75^{c}	18.75^{c}	22.50^{d}	30.00^{c}	19.80^{c}	96.25^{b}
D_8	14.25^{d}	18.00^{c}	21.00^{c}	28.50^{c}	31.50^{bc}	22.65^{c}	95.00^{b}
D_9	14.25^{d}	16.50^{c}	18.75^{c}	24.00^{d}	28.50^{c}	20.40^{c}	96.25^{b}
D_{10}	20.25^{c}	25.50^{b}	29.25^{b}	32.25^{b}	35.25^{b}	28.50^{b}	92.50^{c}
D_{11}	35.25^{a}	38.25^{a}	41.25^{a}	45.00^{a}	48.75^{a}	41.70^{a}	91.25^{c}
D_{12}	31.50^{b}	-	-	-	-	-	-
Mean	20.75	22.8	25.8	30.45	34.2	26.61	
Control	14.25^{cd}	17.25^{c}	24.00^{c}	27.75^{d}	33.00^{bc}	23.25^{c}	96.25^{b}

TABLE II EFFECT OF MAGNETIC FILED ON GERMINATION OF WHEAT SEEDS (BCR CULTIVAR)

Dose	T_{10} (h)	T_{25} (h)	T_{50} (h)	T_{75} (h)	T_{90} h)	MGT (h)	G_{max} (%)
B=125mT							
D_1	7.00^{bc}	10.00^{c}	10.75^{c}	16.75^{b}	21.25^{a}	13.15^{b}	93.75^{ab}
D_2	7.00^{bc}	10.00^{c}	11.50^{c}	15.25^{b}	19.75^{ab}	12.70^{b}	$88.^{75bc}$
D_3	8.50^{b}	10.75^{bc}	13.00^{bc}	16.00^{b}	18.00^{b}	13.25^{b}	90.00^{b}
D_4	8.50^{b}	13.00b	16.00^{b}	19.00^{a}	23.50^{a}	16.00^{a}	92.50^{b}
D_5	10.75^{b}	13.75^{b}	16.75^{b}	21.25^{a}	25.00^{a}	17.50^{a}	97.50^{a}
D_6	15.25^{a}	21.25^{a}	24.25^{a}	-	-	-	
Mean	9.5	13.13	15.38	17.65	21.5	14.52	
B=250mT							
D_7	5.00^{c}	8.00^{c}	9.50^{b}	12.50^{c}	16.25^{c}	10.25^{c}	91.25^{b}
D_8	5.00^{c}	7.25^{c}	8.00^{b}	13.25^{c}	17.75^{c}	10.25^{c}	93.75^{ab}
D_9	5.00^{c}	5.00^{c}	8.00^{b}	12.50^{c}	18.50^{c}	9.80^{c}	96.25^{a}
D_{10}	14.00^{b}	17.00^{b}	20.00^{a}	18.00^{b}	23.75^{b}	18.55^{b}	82.50^{c}
D_{11}	17.75^{a}	20.75^{a}	23.75^{a}	26.75^{a}	29.00^{a}	23.60^{a}	95.00^{a}
D_{12}	17.00^{a}	22.25^{a}	-	-	-	-	
Mean	10.63	13.38	13.83	16.6	21.05	14.49	
Control	7.00^{bc}	10.00^{c}	12.25^{c}	16.00^{b}	19.00^{ab}	12.15^{b}	92.50^{b}

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