Effect of Magnetic Field on Seed Germination of Two Wheat Cultivars

Ahmad Gholami¹, Saeed Sharafi² and Hamid Abbasdokht¹

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. T₁₀ for doses D₅, D₆, D₇ and D₈ 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 B₁ =125mT and B₂ = 250mT; the geometric characteristics are 7.5cm external diameter, 3cm internal diameter, 1cm high for B₁ and 1.5cm high for B₂. 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 D₁-D₁₂ applied were obtained by exposing the seeds to each magnetic field induction for different time, as follows: 1-Exposure to 125 mT: D₁ (10min), D₂ (20min), D₃ (30min), D₄ (1h), D₅ (24h), D₆ (continuous exposure). 2-Exposure to 250 mT: D₇ (10min), D₈ (20min), D₉ (30min), D₁₀ (1h), D₁₁ (24h), D₁₂ (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
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°C, night temperature 18±2°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 \(G_{\text{max}}\). 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 \(G_{\text{max}}\), 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 D5, D6, D11 and D12 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 \(\approx 3\) 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]).](image)
Control 7.00a 10.00 12.50 16.00b 19.00ab 12.15b 92.50b

**TABLE II** \(\text{EFFECT OF MAGNETIC FIELD ON GERMINATION OF WHEAT SEEDS (OMID CULTIVAR)}\)

<table>
<thead>
<tr>
<th>Dose</th>
<th>(T_0) (h)</th>
<th>(T_{50}) (h)</th>
<th>(T_{10}) (h)</th>
<th>(T_{25}) (h)</th>
<th>(T_{50}) (h)</th>
<th>Mean (h)</th>
<th>(G_{max}) (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(B=125\text{mT})</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.00</td>
<td>15.75 17.50 18.75 22.50 30.00 22.50</td>
<td>19.80 98.25b</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.25</td>
<td>18.00 20.00 25.00 30.00 35.00 25.00</td>
<td>20.40 96.25b</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20.25</td>
<td>22.50 29.00 32.00 37.50 35.00 28.50</td>
<td>39.00 95.00b</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35.25</td>
<td>38.25 41.25 45.00 48.50 41.70 41.25</td>
<td>50.00 91.25c</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>31.50</td>
<td>- - - - - -</td>
<td>- - -</td>
<td>32.61</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>14.25 17.25 24.00 27.75 33.00 23.25</td>
<td>96.25b</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**TABLE II** \(\text{EFFECT OF MAGNETIC FIELD ON GERMINATION OF WHEAT SEEDS (BCHR CULTIVAR)}\)

<table>
<thead>
<tr>
<th>Dose</th>
<th>(T_0) (h)</th>
<th>(T_{50}) (h)</th>
<th>(T_{10}) (h)</th>
<th>(T_{25}) (h)</th>
<th>(T_{50}) (h)</th>
<th>Mean (h)</th>
<th>(G_{max}) (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(B=125\text{mT})</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.00a</td>
<td>10.00 10.75 16.75 21.25 13.15 93.75a</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.60a</td>
<td>10.00 11.50 15.25 19.75 12.70 88.76a</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.50a</td>
<td>10.75a 13.00 16.00 19.00 13.25 90.00a</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.50a</td>
<td>13.00 16.00 19.00 23.50 16.00 92.50a</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.75a</td>
<td>13.75a 16.75 21.25 25.00 17.50 97.50a</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15.25a</td>
<td>21.25 24.25 - - - - -</td>
<td>14.52</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>9.5 13.13 15.38 17.65 21.5 14.52</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(B=250\text{mT})</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.00a</td>
<td>8.00 9.50 12.50 16.25 10.25 91.25a</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.00a</td>
<td>7.25 8.00 13.25 17.75 10.25 93.75a</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.00a</td>
<td>8.00 12.50 15.25 18.50 9.80 92.50a</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.00a</td>
<td>17.00 20.00 18.00 23.75 18.55 82.50</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17.50a</td>
<td>20.75 23.75 26.75 29.00 23.60 95.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17.00a</td>
<td>22.25 - - - - -</td>
<td>14.49</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>10.63 13.38 13.83 16.6 21.05 14.49</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

REFERENCES