Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Vol 3 (2) January 2014: 263-268

Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD
Global Impact Factor 0.533
Universal Impact Factor 0.9804

ORIGINAL ARTICLE

Effect of Silver Nanoparticles and Magnetic Field on the Yield and Chemical Composition of *Triticum aestivum* L. seedlings

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ABSTRACT

In order to study the effect of silver nanoparticles and magnetic field on *Triticum aestivum.* Experiments were carried out with four treatments in 10 days. Treatments were including (CON) control, (MF) magnetic field with B=1.8 mT for 1h per day in 10 days, (SNPs) silver nanoparticles (50 ppm), (MF+SNPs) magnetic field plus silver nanoparticles. Results showed that silver nanoparticles (SNPs) had the highest yield and chemical composition while rate of yield and chemical composition in group of treated by magnetic field (MF) had the lowest. Experiment treatments had significantly effects on traits such as the plant height, fresh and dry weight, lenght of root and shoot. It seems that silver nanoparticles (50 ppm) had the best effect on *Triticum aestivum* growth, root and stem length, weight of stem fresh and dry, germination rate, seedling height, phenol, flavonoid, chlorophyll a and b content.
Key words: Antioxidant activity, Physiological factors, Magnetic field, Silver nanoparticles, *Triticum aestivum*

Received 27/10/2013 Accepted 25/12/2013

INTRODUCTION

Studies carried out show that the technique corresponds well with technique such as silver particles and some magnetic fields (MFs) allowing preparation of high-quality, specially prepared seed is an important, These techniques influenced on yield-forming and performance factors the cultivation of many species of agricultural plants. The chemical and physical treatments evaluated were able to eliminate or satisfactorily change the physiological and chemical factors which consist mainly in treating the seed with various chemicals and physical methods [1]. The organisms and especially those that interact strongly with their immediate environments are expected to be affected as a result to their exposition to silver nanoparticles. Engineered nano materials have received a particular attention for their positive impact in improving many sectors of economy and trade, including consumer products, loom, pharmaceutics, cosmetics, transportation, energy and agriculture etc., and are being increasingly produced for a wide range of applications within industry [2, 3]. Different plants could be sensitive to different combination of magnetic field and exposure time [4], thus further investigations of the nature of magnetic field stimulation are needed. Magnetic field are produced by a voltage gradient and are measured in volts/meter whereas magnetic field are generated by any flow of current and are measured in tesla. Physical methods for pre-sowing treatment of seeds are not only cost effective; they also significantly change the growth of plants with negative or positive affecting the environment. They influence the physiological and biochemical process in the seeds, and thereby contribute to greater vigor and altered crop stand. In some studies physical pre-sowing seed treatment for enhancing the seed performance, if standardized, can lead to commercial application [5]. Magnetic fields have had uses in agriculture of ancient and modern society. The advent of modern technological systems in electric and electronic equipment has, in recent years, changed both interest in and concern about the effects of electromagnetic and magnetic field on plants. Information of the mechanisms of the action of the magnetic field on various biological systems such as cells and tissue of plants, animals and microorganisms, may be effectively used as a means regulating biological activity and removing unfavorable compounds from the bio systems. The aim of the present study was to determine the effects of exposure of magnetic field and silver nanoparticles on physiological and biochemical parameters under laboratory conditions.

MATERIAL AND METHODS

Seed pretreatment with MF

Seeds of *Triticum aestivum* were obtained from Esfahan in Research Center in 2012, Iran. Seeds of *Triticum aestivum* have been used for investigating the influence of magnetic field on the development of plants. The induction of magnetic field has been B= 1.8 mT, measured with a digital tesla-meter (PHYWE, Germany). Magnetic-field-induction value has been chosen according to the opinion that weaker magnetic field has stronger effect on plant productivity. The healthy uniform dry seeds 8.6% of moisture content were selected and seeds kept at the geometric Centre of coil assemblies. Control seeds were kept under similar condition local geomagnetic field only but in the absence of magnetic field. Exposure was 10 days for 1 h per day and control seeds were kept under the similar condition in the absence of the MF. The experiments have been performed in 2012 under laboratory conditions. The natural light cycle was 16 h–light/8h darkness with daily temperature 25°Cand night temperature 22°C.

Seed germination and seedling development

Magnetic field pretreated and control seeds were surface sterilized with 1% NaOCl (w/v) for 5 min, washed thoroughly 3 times with distilled water and then propagated in pots containing soil and sand mixture (1:2). The pots were maintained under natural photoperiod with 35% (w/w) soil moisture content. Seed germination observed at 7th day, and germination seedlings were uprooted and measured the length, fresh and dry weight of 10 days for both control and treated seedlings.

Pigment contents (chlorophyll a, chlorophyll b and carotenoid)

The photosynthetic pigments e.g., Chlorophyll a, b and Carotenoid were extracted in 5 ml of chilled 80% acetone by grinding the leaves of salt treated seedlings in a chilled mortar and pestle. The homogenate was centrifuged at 3000 g for 10 min at 4 ◦C. The absorbance of the resulting supernatant was taken at 480, 645 and 663 nm. Different pigments were estimated using the following formula by Barnes as given below:

Chl a (mg/l)= 12.7 (A663) – 2.69 (A645)

Chl b (mg/l)= 22.9 (A645) –4.68 (A663)

Car (mg/l) = 1000A480 – 1.8Chl a - 85.02Chl b/198

The pigment concentration was calculated in g/g FW of sample and expressed as percent change [6].

Total phenol

Total phenol was determined spectrophotometrically using Folin–Ciocalteu's reagent as described by Bonilla et al. [7]. Briefly, 4 g fresh *Triticum aestivum* (the seed discarded) were ground in liquid nitrogen. A sample was then extracted in 2% HCl in methanol for 24 h in the dark and at room temperature. After centrifugation at 12,000 g for 20 min at 4 ◦C, the supernatant was diluted with the same extract solvent at a suitable concentration for assaying total phenol. Two hundred microliters of diluted extraction was introduced into a 5.0 ml test tube. One milliliters of Folin–Ciocalteu reagent and 0.8 ml sodium carbonate (7.5%) were then added and the contents mixed and allowed to stand for 30 min. Absorption at 765 nm was measured in a Bio wave UV–Vis spectrophotometer (English production). Total phenol content was expressed as gallic acid equivalents (GAE) in milligrams per gram of sample using a standard curve generated with 50, 100, 150, 200, 250, 300, 350, 400, and 500 mg/l of gallic acid (Bonilla et al., 2003).

Determination of flavonoid content

The flavonoid contents of the extracts were determined by the colorimetric method with some modifications [8]. The *Vigna radiata* extract (0.1 ml) was mixed with 1.25 ml of distilled water and 75 µl of a 5% $NaNO_2$ solution. After 5 min, 150 µl of a 10% $AlCl_3.H_2O$ solution was added. After 6 min, 500 µl of 1 M NaOH and 275 µl of distilled water were added to the mixture. The solution was mixed well and the intensity of the pink color was measured at 510 nm. The results were expressed as milligrams of catechin equivalents per gram of sample (mg CEs/g extract).

Statistical analysis

The data obtained from the experiments were analyzed and calculated. As the experimental design is completely randomized design and data for each experiment were analyzed by one-way ANOVA with factorial arrangement to determine the effects of magnetic treatment. Means were compared using Duncan's multiple-range test at a 5% level of significance by SPSS software version 16.

RESULTS AND DISCUSSIONS

One day after treatments, magnetic field decreased germination percentage, in comparison with other groups. Also, the highest and the lowest percentage of germination were observed in silver nanoparticles and magnetic field treatment, respectively(Fig1).

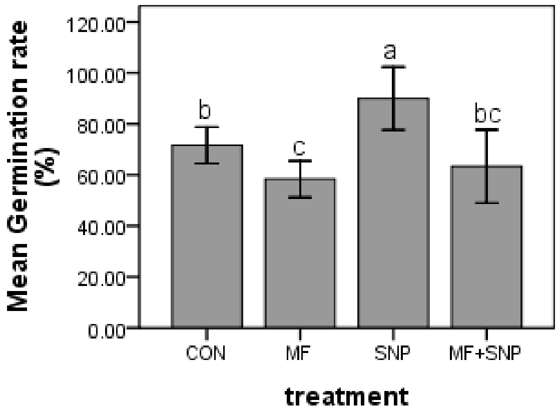

Fig. 1. Influence of magnetic field on rate of seed germination of *Triticum aestivum.* Bars represents means ± standard error. Means followed by the same letter are not significantly different (P<0.05) as determined by Duncan's multiple-range test.

Najafi et al [9] observed that the magnetic field inhibited *Phaseolus vulgaris* growth by the voltage of a specific waveform, depending on the frequency which suggests that the effect of magnetic field on plant growth and development may be sensitive to the waveform and frequency of the source electrical voltage). Results showed that different effect of magnetic field and silver nanoparticles on physiological factors in *Triticum aestivum.* Maximum and minimum root and shoot length were observed in silver nanoparticles and magnetic field treatments, respectively (Fig2).

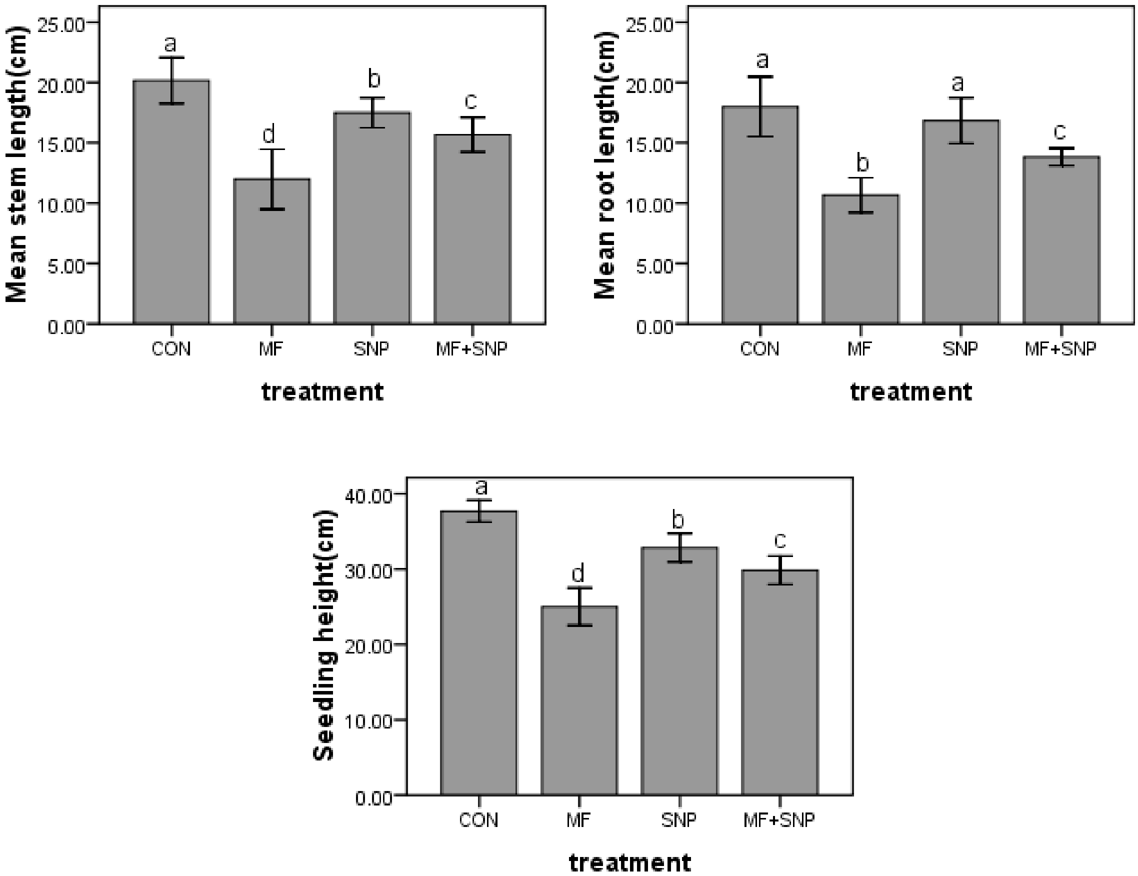

Fig. 2. Influence of magnetic field on *Triticum aestivum* seedling height, length of root and stem. Bars represent means ± standard error. Means followed by the same letter are significantly different (P< 0.05) as determined byDuncan's multiple-range test.

Fig. 3. Comparision of root length and seedling height of *Triticum aestivum* in control and pretreatment groups by magnetic field and silver nanoparticles.

The present findings confirm that all growth and biochemical variables of *Triticum aestivum* drastically altered due to the stimulatory effects of magnetic field. In this study, in an attempt to understand the mechanism by which MF changes the growth, yield and biochemical of crop plants.
In all the antiparallel experimental runs it is evident, to a level of confidence of 95% or higher, that antiparallel treatment results in a significant inhibition of the rate of plant growth. A similar analysis of antiparallel in present study gave essentially identical results. For the parallel case, a significant result was observed in some case, and in this case a stimulation effect of growth is present which is quite similar to that reported by Pittman for other plants [10] can be confine free radicals over extended periods that are long enough to allow an external magnetic field to affect spin evolution. Shah and Belozerova [11] reported that metal nanoparticles decreased length of root, however, it enhanced germination and root length in Lettuce seeds.

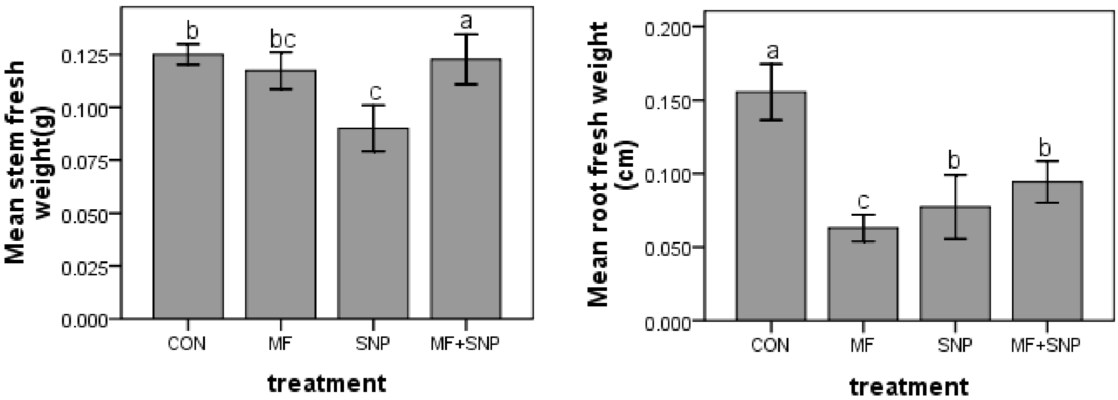

Fig. 4. Influence of magnetic field on wet weight in root and stem of *Triticum aestivum.* Bars represent means ± standard error. Means followed by the same letter are not significantly different ($P < 0.05$) as determined by Duncan's multiple-range test.

In this study, the highest of chlorophyll a and b content observed in Group of treatment with silver nanoparticles. Yano et al [12] have observed a negative effect on fresh and dry weight, cotyledons, leaf area in early growth of radish seedlings. Seedling height decreased 50 % in MF treatment over than control, and fresh and dry biomass also decreased respectively. The negative effect of MF on rate of seed germination and viability was reported by some researchers [13], and suggested that decreased rate of seed germination and seed vigour under the treatment of magnetic field would influence the biochemical processes that involve free radical formation and changes the total phenol and flavonoid content of the treated by magnetic field were not significantly changed with control groups .

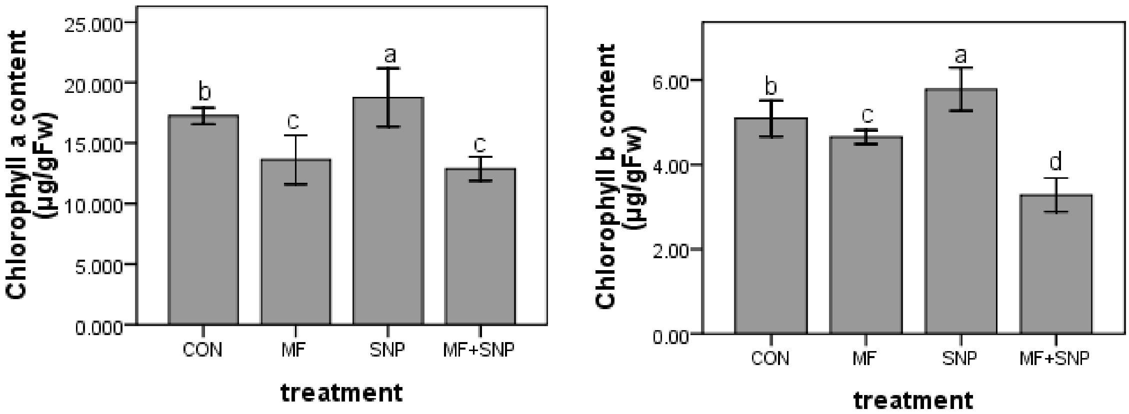

Fig. 5. Influence of magnetic field on pigments content (Chlorophyl a and b) of *Triticum aestivum.* Bars represent means ± standard error. Means followed by the same letter are significantly different (P<0.05) as determined by Duncan's multiple-range test.

Dhawi et al [14] observed that the magnetic field decreased content of chlorophyll a and b in all treatment compared with control in dates. Also, Atak et al [15] showed that that the magnetic field decreased content of chlorophyll a and b in all treatment compared with control in soybean. A negative magnetic field releases free radicals which have an essential role in electron transfer and chemical reaction. The reaction between the external magnetic field and the moment of unpaired electrons of biochemical compounds in plants absorbs energy. The absorbed energy can affect the chloroplast magnetic moment and disturb photosynthetic pigments. In some studies, Nano-TiO2 enhanced photosynthesis and other metabolisms in Spinach [16].

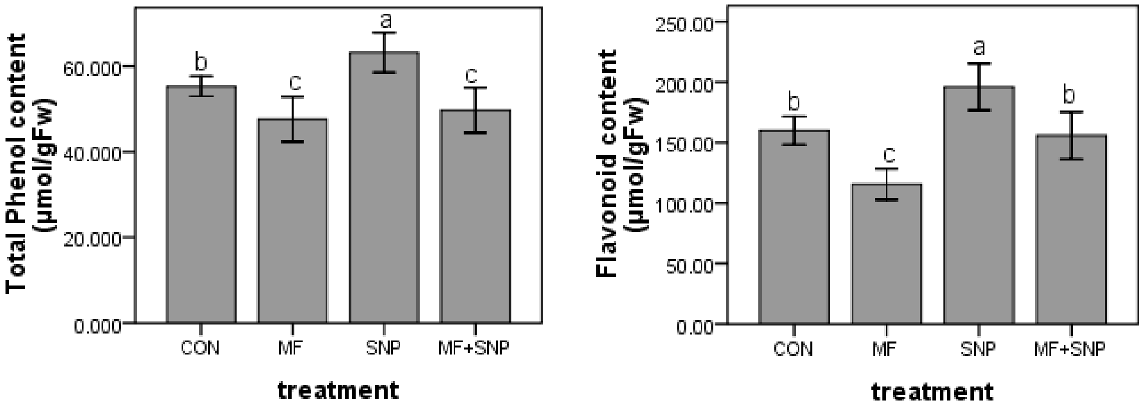

Fig. 6. Influence of magnetic field on flavonoid and Phenol content of *Triticum aestivum.* Bars represent means plus standard error. Means followed by the same letter are significantly different (P<0.05) as determined by Duncan's multiple-range test.

In this study, silver nanoparticles and magnetic field increased and decreased content of the flavonoid and phenol, respectively. Additionally a significant correlation was found between total phenol content and antioxidant activity. Therefore, it is possible that the phenolic compounds significantly contributed to the antioxidant activity in plants. However, other substances, e.g. glucosinolates, might contribute to the antioxidant activity in plants as well. The mechanism of stimulating effect of MF-treatment on seed germination and seedling growth was unknown, but several theories have been proposed, including biochemical changes or altered enzyme activities. Plant processes such as growth, photosynthesis, mineral nutrition, water and transport are quite related to the motion of Ca^{2+}ion in cells. Ions in the cell have the ability to absorb magnetic energy corresponding to specific parameters related to their vibration and rotation energy sublevels. This phenomenon represents a kind of resonance absorption and could explain the stronger effect of applying definite values and The electron transfer, radical-pair intermediates and triplet yields, and emission intensity of magnetic field induction, observed by Martinez et al. [17]. However, most studies have suggested that MFs affect water absorption [18, 19]. An increase in water uptake rate due to the applied magnetic field has been reported, which may be the explanation for the increase in the germination seed of treated lettuce seeds [20].

CONCLUSION

The use of silver nanoparticles (SNPs) to accelerate germination, early seedling growth and biochemical compounds stimulation of *Triticum aestivum* seed is possible. The impact of magnetic fields may be positive or negative on plant growth, depending upon the direction of magnetic field lines with plant growth and prevailing conditions where the event occurs. SNPs increased the rate and percentage of germination of *Triticum aestivum* seed. Also, root and stem length, fresh weight and dry weight of stem were increased with exposuring to SNPs whereas MF treatment decreased these factors. On the other hands, our results cleared that the fresh weight and dry weight of root decreased under SNPs. Stimulation of *Triticum aestivum* plants with MF in more advanced stages may have significant positive effects on plant growth and development.

REFERENCES

1. Atak, C., Emiroglu O., Alikamanoglu, S., and Rzakoulive, A., 2003. Journal of Cell and Molecular Biology. 2,113-119.
2. Novack, B. and Bucheli, T.D. (2007) Occurrence, behavior and effect of nanoparticles in the environment. *Environmental Pollution*., 150, 5-22.
3. Roco, M.C. (2003) Nanotechnology convergence with modern biology and medicine. *Current Opinion in Biotechnology*., 14, 337-346.
4. Majd A, Shabrangi A, Bahar M, Abdi S. Effect of AC and DC Magnetic Fields on Seed Germination and Early Vegetative Growth in Brassica Napus L. PIERS Proceedings 2009; August 18-21, Moscow, Russia.
5. Tahir NAR, Karim HFH. Impact of magnetic application on the Parameters related to growth of Chickpea (Cicer arietinum L.). Biological Sciences 2010; 3(4): 175-184.
6. Barnes, J.D., Balaguer, L., Manriques, E., Elvira, S. and Davison, A.W. (1992) A reappraisal of the use of DMSO for the extraction and determination of chlorophyll a and b in lichens and higher plants. *Environmental and Experimental botany.* 32, 85-100.
7. Bonilla, E.P., Akoh, C.C., Sellappan, S. and Krewer, G., 2003. Phenolic content and antioxidant capacity of Muscadine grapes. *Journal of Agriculture and Food Chemistry.,* 51, 5497–5503
8. Jerman, I., Jeglic, A. and Fefer, D. (1989) Magnetic stimulation of normal and cut spruce seedlings*. Biology Vestn*., 37, 45-56.
9. Najafi, S., Heidari, R. and Jamei, R. 2013. Influence of the magnetic field stimulation on some biological characteristics of *Phaseolus vulgaris* in two times. Global Journal of Sciences, Engineering and Technology. 11:51-58.
10. Pittman, U. J., 1977. Effects of magnetic seed treatment on yields of barely, wheat, and oats in Southern Alberta. Can. J. Plant Sci. 57: 37-45.
11. Shah, V. and Belozerova, I. 2009. Influence of metal nanoparticles on the soil microbial community and germination of lettuce seeds*. Water Air and Soil Pollution*. 97:143-148.
12. Yano A, Ohashi Y, Hirasaki T, Fujiwara K., 2004. Effect of a 60 Hz magnetic field on photosynthetic CO_2 uptake and early growth of radish seedlings. Bioelectromagnetics 25: 572-581.
13. Piatti E, Albertini MC, Baffone W, Fraternale D, Citterio B, Piacentini MP, Dacha M, Vetrano F, Accorsi A., 2002. Antibacterial effect of a magnetic field on *Serratia marcescens* and related virulence to *Hordeum vulgare* and *Rubus fruticosus* callus cells. Comp Biochem Physiol B Biochem Mol Biol 132: 359-365.
14. Dhawi, F. and J. M. Al-Khayri. 2009. 'Magnetic fields induce changes in photosynthetic pigments content in Date Palm (Phoenix dactylifera L.) seedlings'. Open Agri J. 3: 1-5.
15. Atak, C., O. Celik and A. Olgun. 2007. 'Effect of magnetic field on peroxidase activities of soybean tissue culture'. Biotechnol. 21(2): 166-171.
16. L. Yang and D. J. Watts, "Particle surface characteristics may play an important role in phytotoxicity of alumina nanoparticles" Toxicol Lett, 2005; vol. 158, pp. 122-132.
17. Martínez E, Carbonell MV, Flórez M, Amaya JM, Maqueda R. Germination of tomato seeds under magnetic field. International Agrophysics 2009b; 23: 45-49.
18. Galland P, Pazur A. Magnetoreception in plants. Plant Research 2005; 118: 371-389.
19. Pang XF, Deng B. Investigation of changes in properties of water under the action of a magnetic field. Science in China Series G-Physics Mechanics Astron 2008; 51(11):1621-1632.
20. Calatayud A, Iglesias DJ, Talon M, Barreno E. Effect of 2-month ozone exposure in spinach leaves on photosynthesis, antioxidant systems and lipid peroxidation. Plant Physiology and Biochemistry 2003; 41: 839-845.

How to cite this article:
Saeideh N, Rashid J, Neda F. Effect of Silver Nanoparticles and Magnetic Field on the Yield and Chemical Composition of *Triticum aestivum* L. seedlings. Bull. Env. Pharmacol. Life Sci. 3 (2) 2014: 263-268